Appendix A. Public Involvement Memorandum

CENAB-WA-EN 12 JUNE 2007

MEMORANDUM FOR RECORD

SUBJECT: Comments Received on the Draft Environmental Assessment Regarding System Improvements of the Dalecarlia WTP and McMillan WTP for Disinfection and pH Control

1. In order to solicit comments from specific individuals, groups, elected officials, agencies, and the general public regarding the Draft Environmental Assessment (Draft EA) for System Improvements of the Dalecarlia WTP and McMillan WTP for Disinfection and pH Control, Washington Aqueduct prepared a Public Notice (attached at Tab A) published in several newspapers (*Washington Post* [April 19, 2007], *Northwest Current* [April 18, 2007], *Bethesda Gazette* [April 18, 2007], *Washington Afro-American Newspaper* [April 21, 2007], and *DC North* [May 2007]). Copies of the Draft EA were mailed directly to interested individuals, groups, elected officials, and agencies (list and copies of cover letters are attached at Tab B). On April 20, 2007, the Draft EA with Appendices was available on the project website (http://washingtonaqueduct.nab.usace.army.mil/hypochlorite.htm). Additionally, the Draft EA complete with Appendices and the Administrative Record were made available at the Mount Pleasant and Palisades Branches of the District of Columbia Public Library and the Little Falls Branch of the Montgomery County Public Library.

2. Washington Aqueduct received seven separate pieces of correspondence containing formal comments: from the District of Columbia Department of Transportation, the District of Columbia Department of the Environment, the District of Columbia Historic Preservation Office, the National Park Service, the Montgomery County Planning Department, Maryland Department of the Environment, and the Maryland Historic Trust. Copies of these correspondences are attached (at Tab C).

a. The District of Columbia Department of Transportation indicated concurrence with the analysis and findings in the Draft EA, and endorsed an end of the use of liquid chlorine and replacement with use of aqueous sodium hypochlorite. This comment does not require a response.

b. The District of Columbia Department of the Environment recommended the development of a spill prevention and emergency response plan as part of the implementation of the proposed action. Washington Aqueduct maintains a comprehensive Emergency Response Plan which incorporates spill prevention and emergency response planning components. This document will be modified in order to include introduction of new bulk chemicals.

c. The District of Columbia Historic Preservation Office indicated that due to the preliminary nature of the Draft Environmental Assessment, they had no comments. The Historic Preservation Office will be consulted with by Washington Aqueduct during the design phase of the project in order to comply with the National Historic Preservation Act, and to ensure that historic structures and features will be protected.

d. The National Park Service requested that the Environmental Assessment explicitly address three points: that new buildings were not to be visible from park land, and have no adverse visual impact from the Potomac Gorge; that contractors, similar to all commercial vehicles, are prohibited from using the local national park roads; and that safety measures and spill containment plans be detailed. Since the existing site of the Dalecarlia Water Treatment Plant is relatively clear, it may be impossible to prevent any possible off-site views of existing buildings and any new buildings, including from adjacent park land (particularly during winter months). However, the proposed new building would be similar in nature to the existing buildings and would not change the overall existing visual aesthetic from the perspective of park land or from any other perspective; therefore no adverse visual impacts are expected, as is discussed in the Environmental Assessment. Commercial vehicles are prohibited by law from National Park roads, and no park roads were identified as possible truck routes in the Environmental Assessment and in other referenced documents. The Environmental Assessment will be modified to explicitly confirm the prohibition. As indicated in paragraph (b), the Washington Aqueduct Emergency Response Plan will be required to be modified to incorporate the potential use of new bulk chemicals.

e. The Montgomery County Planning Department staff indicated a concurrence with the findings of the Draft EA related to the impacts analysis for the alternatives considered. Additionally, the agency indicated that the changes to traffic from the proposed action would have a minor impact, however the agency encouraged deliveries to be made outside of peak travel periods. The agency also indicated that they found no issues of concern to the nearby Capital Crescent Trail, but recommended contact with the Coalition for the Capital Crescent Trail. Washington Aqueduct concurs with the comments made by the Montgomery County Planning Department staff, and has already established contact with the Coalition for the Capital Crescent Trail. Washington Aqueduct sent the scoping notice to the Coalition, and has continued correspondence by sending the Draft EA.

f. The Maryland Department of the Environment indicated that they had no comments to make on the Draft EA. This letter did not contain any comments requiring a response.

g. The Maryland Historic Trust indicated that they have determined there would be no adverse impacts on historic structures due to the proposed action, but that any proposed changes to historic structures should be submitted for comment. This comment does not require a response.

MICHAEL C. PETERSON
Environmental Engineer

TAB A

PUBLIC NOTICE OF AVAILABILITY

Draft Environmental Assessment – Proposed System Improvements of the Dalecarlia WTP and the McMillan WTP for Disinfection and pH Control

Washington Aqueduct, Washington, DC

Washington Aqueduct, a Division of the U.S. Army Corps of Engineers (USACE), Baltimore District, operates the Dalecarlia and McMillan Water Treatment Plants (WTPs) in Washington, D.C., serving potable water to over one million persons in the District of Columbia and northern Virginia. The treatment process removes solid particles from the Potomac River supply water, treats and disinfects the water, and distributes the finished water to the metropolitan service area. Washington Aqueduct is considering modification of two components of the treatment process – disinfection and control of pH – at both the Dalecarlia WTP and the McMillan WTP to enhance the reliability of the production of safe drinking water and to reduce operational risk. Washington Aqueduct has prepared a Draft Environmental Assessment (EA) on the proposed system modifications.

Disinfection

Bulk liquid chlorine, created by compressing pure chlorine gas, has been used throughout the history of disinfection at the Dalecarlia WTP and the McMillan WTP. Due to the hazardous nature of the liquid chlorine, engineering and management controls are employed to minimize risks associated with its handling and use. As an alternative to using liquid chlorine, chlorine as aqueous sodium hypochlorite, an inherently safer form, is commercially available and frequently used in the water treatment industry. In the Draft EA, Washington Aqueduct has considered converting the disinfection process at the Dalecarlia WTP and the McMillan WTP from using bulk liquid chlorine to using aqueous sodium hypochlorite for disinfection in order to eliminate the inherent risks associated with storing and handling liquid chlorine.

pH Control

In 2004, in the interest of managing corrosion observed in parts of the District of Columbia water distribution system, the United States Environmental Protection Agency approved a Washington Aqueduct plan to take steps to modify the water treatment process. The initial step taken was to introduce a chemical corrosion inhibitor. In addition, the acceptable range for pH in finished water was modified. So in the Draft EA, in order to comply with the new corrosion control requirements for drinking water in the District of Columbia, Washington Aqueduct considered using caustic soda for pH control as a supplementary or replacement process for lime, which is currently used at both the Dalecarlia WTP and the McMillan WTP. During the development of the Draft EA, it was determined that sulfuric acid will also be needed periodically to control pH at the McMillan WTP.

Preferred Alternative

The preferred alternative, which is also the environmentally preferred alternative, identified in the Draft EA includes the following features:

- Design, construction and operation of bulk sodium hypochlorite storage and feed systems at both the Dalecarlia WTP and the McMillan WTP, with consideration for facilitating the possible installation of on-site sodium hypochlorite generation equipment in the future.
- Continued study and future consideration of on-site sodium hypochlorite generation systems for the Dalecarlia WTP and the McMillan WTP.
- Design, construction, and operation of a caustic soda storage and feed system in order to trim pH following pH adjustment with lime at the Dalecarlia WTP.
- Design, construction, and operation of caustic soda and sulfuric acid storage and feed systems for the control of pH at the McMillan WTP.
- Construction of a new structure adjacent to an existing storage building at the Dalecarlia WTP.
- No new structures at the McMillan WTP.

The preferred alternative allows the Washington Aqueduct to eliminate the use of liquid chlorine at both the Dalecarlia WTP and McMillan WTP, to achieve the corrosion control requirements for pH, and to further investigate the potential option of generating aqueous sodium hypochlorite on-site at the two facilities.

The Draft EA can be viewed at the website listed below, at the Palisades and Mt. Pleasant Branches of the District of Columbia Public Library, or at the Little Falls Branch of the Montgomery County Public Library. Washington Aqueduct is soliciting information from the public applicable to the Draft EA. Any comments received will be considered in the preparation of the Final EA. Upon completion, the Final EA will be made available for public review. Comments must be submitted or postmarked by May 21, 2007. Contact information is shown below.

For further information, please contact the Washington Aqueduct NEPA Coordinator at the address shown, at 202-764-0025 or at washingtonaqueduct@usace.army.mil	U.S. Army Corps of Engineers Baltimore District, Washington Aqueduct 5900 MacArthur Boulevard NW Washington, D.C. 20016-2514

Website: http://washingtonaqueduct.nab.usace.army.mil/

TAB B

DEPARTMENT OF THE ARMY
WASHINGTON AQUEDUCT
U.S. ARMY CORPS OF ENGINEERS, BALTIMORE DISTRICT
5900 MACARTHUR BOULEVARD, N.W.
WASHINGTON, D.C. 20016-2514

April 17, 2007

Office of the General Manager

Honorable Jim Graham
Councilmember Ward 1
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 105
Washington, DC 20004

Dear Mr. Graham:

Washington Aqueduct has completed the Draft Environmental Assessment (EA) for system improvements of the Dalecarlia Water Treatment Plant (WTP) and McMillan WTP for disinfection and pH control. All of the alternatives considered in the Draft EA were associated with no anticipated significant adverse impacts. A preferred alternative was identified involving the phasing-out of the use of liquid chlorine and replacing it with bulk aqueous sodium hypochlorite, a much safer alternative. Additionally, the preferred alternative includes the incorporation of caustic soda at both facilities and sulfuric acid at the McMillan WTP into the pH control strategy in order to enhance the efforts to control corrosion in the distribution system drinking water.

I have enclosed a printed copy of the Draft EA. The appendices to the Draft EA can be downloaded from the project website:

http://washingtonaqueduct.nab.usace.army.mil/hypochlorite.htm

The Draft EA and the complete Administrative Record can be viewed at the Mt. Pleasant Branch or the Palisades Branch of the District of Columbia Public Library and at the Little Falls Branch of the Montgomery County Public Library.

Washington Aqueduct is soliciting information or comments applicable to the Draft EA. Any comments received will be considered in the preparation of the Final EA. Upon completion, the Final EA will be made available for public review. Comments must be submitted or postmarked by May 21, 2007.

Any questions can be directed to Mr. Michael Peterson at 202-764-0025 or michael.c.peterson@usace.army.mil.

Sincerely,

Thomas P. Jacobus
General Manager

Enclosure

Mr. William O. Howland, Director
D.C. Department of Public Works
2000 14th Street, NW
Washington, DC 20001

Mr. Emeka C. Moneme, Director
D.C. Department of Transportation
2000 14th Street, NW, 6th Floor
Washington, DC 20001

Mr. Tom Henderson, Administrator
Solid Waste Management
D.C. Department of Public Works
2000 14th Street, NW
Washington, DC 20001

Mr. John Wolflin, Field Supervisor
Chesapeake Bay Field Office
U.S. Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401

Mr. Joseph Lawler, Director
National Capital Region
National Park Service
1100 Ohio Drive, SW
Washington, DC 20242

Mr. Neil O. Albert
Office of the Deputy Mayor for Planning and Economic Development
John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 317
Washington, DC 20004

Ms. Linda Singer
Attorney General for the District of Columbia
1350 Pennsylvania Avenue, NW
Suite 409
Washington, DC 20004

Honorable Isiah Leggett, County Executive
Executive Office Building
101 Monroe Street
Rockville, MD 20850

Honorable Paul Ferguson
Chairman, Arlington County Board
2100 Clarendon Boulevard, Suite 300
Arlington, VA 22201

Mr. Don L. Klima, Director
Office of Federal Agency Programs
Advisory Council on Historic Preservation
1100 Pennsylvania Avenue, NW, Suite 803
Washington, DC 20004

Brian Lee, Interim Chief
District of Columbia Fire and Emergency Medical Services
1923 Vermont Avenue, NW
Washington, DC 20001

Cathy L. Lanier, Chief of Police
Metropolitan Police Department
Government of the District of Columbia
300 Indiana Avenue, NW
Washington, DC 20001

Mr. David J. Robertson
Executive Director
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201

Ms. Shari T. Wilson, Director
Water Management Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230

Honorable Carol Schwartz
Councilmember-At-Large
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 404
Washington, DC 20004

Mr. Ron Carlee, County Manager
Arlington County
1 Courthouse Plaza
2100 Clarendon Boulevard
Arlington, VA 22201

Ms. Patricia E. Gallagher
Executive Director
National Capital Planning Commission
401 9th Street, NW, Suite 500
Washington, DC 20576

Mr. William Roper, Director
Department of Environmental Services
1 Courthouse Plaza
2100 Clarendon Boulevard, Suite 900
Arlington, VA 22201

Ms. Lisa Burcham, State Historic Preservation Officer
Historic Preservation Division
D.C. Office of Planning
801 North Capitol Street, NE, Suite 4000
Washington, DC 20002

Ms. Lucia Leith
Western Avenue Citizens Association
4626 Western Avenue
Bethesda, MD 20816

Ms. Fariba Kassiri, Acting Director
Montgomery County Government
Department of Environmental Protection
255 Rockville Pike
Rockville, MD 20850

Mr. Arthur Holmes, Jr., Director
Montgomery County Department of Public Works and Transportation
101 Monroe Street; 10th Floor
Rockville, MD 20850-2450

Honorable Roger Berliner
District 1 Councilmember
Montgomery County Council
100 Maryland Avenue
Rockville, MD 20850

Mr. Jerry N. Johnson
General Manager
D.C. Water and Sewer Authority
5000 Overlook Avenue, SW
Washington, DC 20032

Ms. Wanda S. Durdent, Interim Director
D.C. Parks and Recreation Department
3149 16th Street, NW
Washington, DC 20010

Mr. F. Wyatt Shields
City Manager
City of Falls Church
300 Park Avenue
Falls Church, VA 22046

Honorable Robin Gardner
Mayor, City of Falls Church
300 Park Avenue
Falls Church, VA 22046

Honorable Benjamin L. Cardin
509 Hart Senate Office Building
U.S. Senate
Washington, DC 20510

Mr. Burton Gray, President
Cabin John Citizens Association
PO Box 31
Cabin John, MD 20818

Mr. Jerry L. Price
Chief Operating Officer
Sibley Memorial Hospital
5255 Loughboro Road, NW
Washington, DC 20016-2695

Honorable Jim Graham
Councilmember Ward 1
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 105Washington, DC 20004

Honorable Jack Evans
Ward 2 Councilmember
John A. Wilson Building
1350 Pennsylvania Avenue, NW, Room 106Washington, DC 20004

Mr. David Brewster
Office of Maryland Senator Brian Frosh
446 Miller Senate Office Building
Annapolis, MD 21401-1991

Honorable Mary Cheh
Councilwoman Ward 3
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 108
Washington, DC 20004

Ms. Brenda Creel, General Manager for Environmental Services
City of Falls Church
300 Park Avenue
Falls Church, VA 22046

Mr. Peter Rousselot, Chair
Arlington County Fiscal Affairs Advisory Commission
3182 Key Boulevard
Arlington, Virginia 22201

Ms. Tania Tully, SHPO
Maryland Historical Trust
Division of Historical and Cultural Programs
100 Community Place
Crownsville, MD 21032-2023

Ms. Debra Graham
Westmoreland Citizens Association
5407 Duvall Drive
Bethesda, MD 20816

Mr. Lucian Pugliaresi
Spring Valley-Wesley Heights Citizens Association
c/o LPI Consulting, Inc.
1031 31st Street, NWWashington, DC 20007

Ms. Tanya Tomasko Spano
Department of Environmental Programs
Metropolitan Washington Council of Governments
777 North Capitol Street, NE
Washington, DC 20002-4226

Mr. Raymond Roach
Washington DC Regional Office
Natural Resources Defense Council
1200 New York Ave., NW, Suite 400Washington, DC 20005

Honorable Chris Van Hollen
United States House of Representatives
1707 Longworth House Office Building
Washington, DC 20515

Honorable Jim Moran
United States House of Representatives
2239 Rayburn Building
Washington, DC 20515-4608

Mr. George S. Rizzo
Mail Code: 3WP22
U.S. EPA Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Mr. William S. Arguto
U.S. EPA Region III
Mail Code: 3EA30
1650 Arch Street
Philadelphia, PA 19103-2029

Ms. Mary Letzkus
U.S. EPA Region III
Mail Code: 3WP13
1650 Arch Street
Philadelphia, PA 19103-2029

Ms. Lori Byrne, Environmental Review Specialist
MD DNR - Wildlife and Heritage Service
Tawes State Office Building, E-1
580 Taylor Avenue
Annapolis, MD 21401

Ms. Elizabeth Adams
Westmoreland Citizens Association
5111 Dalecarlia Drive
Bethesda, MD 20816

Honorable Barbara A. Mikulski
509 Hart Senate Office Building
U.S. Senate
Washington, D.C. 20510

Ms. Sherry Krest
Chesapeake Bay Field Office
U.S. Fish and Wildlife Service
177 Admiral Cochrane DriveAnnapolis, MD 21401

Honorable Eleanor Holmes Norton
United States House of Representatives
2136 Rayburn House Office Building
Washington, DC 20515

Mr. William S. Spencer, President
Palisades Citizens Association
2825 49th St NW
Washington, DC 20007-1010

Ms. Rachel W. Thompson
ANC 3D Commissioner
5835 Sherier Place, NW
Washington, DC 20016-5323

Mr. Thomas Luebke, Secretary
U.S. Commission of Fine Arts
National Building Museum
401 F Street, NW, Suite 312
Washington, DC 20001-2728

Mr. Dean F. Amel, Chair
Arlington County Environment and Energy Conservation Commission
3013 N. 4th St.Arlington, VA 22201

Mr. Kevin Brandt, Superintendent
C&O Canal NHP Headquarters
1850 Dual Highway, Suite 100
Hagerstown, MD 21740

Ms. Alma H. Gates
Chair, ANC 3D
PO Box 40846
Palisades StationWashington, DC 20016

Mr. Ron Tripp
Citizens' Coordinating Committee on Friendship Heights
5330 Sherrill Ave
Chevy Chase, MD 20815

Mr. Barry Lucas
DCWASA - DETS
5000 Overlook Ave., SW
Washington, DC 20032

Honorable David A. Catania
Councilmember-At-Large
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 110
Washington, DC 20004

Honorable Phil Mendelson
Councilmember-At-Large
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 402Washington, DC 20004

Honorable Kwame R. Brown
Councilmember-At-Large
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 406Washington, DC 20004

Ms. Deborah J. Snead, Director
Bethesda-Chevy Chase
Regional Services Center
4805 Edgemoor Lane
Bethesda, MD 20814

Honorable Marilyn Praisner, Council President
Montgomery County Council
Stella B. Werner Council Office Building
100 Maryland Avenue
Rockville, MD 20850

Mr. Neil J. Pedersen, Administrator
Mail Stop C-400
State Highway Administration
P.O. Box 717
Baltimore, MD 21203-0717

Ms. Norma Danis Spiegel, President
Glen Echo Heights Citizens Association
5305 Wapakoneta Road
Bethesda, MD 20816

Ms. Faroll Hamer, Acting Director
Montgomery County Department of Park & Planning, MNCPPC
8787 Georgia Avenue
Silver Spring, MD 20910

Mr. David Vela, Superintendent
George Washington Memorial Parkway
Turkey Run Park
McLean, VA 22101

Mr. Arrigo Mongini, President
Mohican Hills Citizens' Association
5541 Mohican Road
Bethesda, MD 20816

Mr. Leonard Kogan, President
Sumner Village Community Association
4910 Sentinel Drive
Bethesda, MD 20816

Mr. Corey R. Buffo, Interim Director
District Department of the Environment
51 N Street NE, 6th Floor
Washington, DC 20002

Mr. Glen A. Smith
Regional Planner
Regional and Intermodal Planning Division
Maryland State Highway Administration
707 N. Calvert St - C-502
Baltimore, MD 21202

Mr. John Gill, President
Sumner Citizens' Association
5124 Baltan Road
Bethesda, MD 20816

Ms. Phyllis R. Edelman, President
Springfield Civic Association
P.O. Box 644
Glen Echo, MD 20815

Honorable Nancy Floreen
At-Large Councilmember
100 Maryland Ave, 6th Floor
Rockville, MD 20850

Mr. Royce Hanson
Chairman, Montgomery County Planning Board
8787 Georgia Avenue
Silver Spring, MD 20910

Mr. Stephen E. Baldwin
Western Montgomery County Citizens Advisory Board
6422 Kenhowe Drive
Bethesda, MD 20817

Ms. Lisa Vita
Zoning Committee, Springfield Civic Association
5904 Searl Terrace
Bethesda, MD 20816

Mr. Nasser M. Kamazani
Montgomery County Department of Environmental Protection
Watershed Management Division
255 Rockville Pike, Suite 120
Rockville, MD 20850-4166

Ms. Jacqueline Arguelles
ANC 1A01 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Calvin Woodland
ANC 1A02 Commisioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Alexander Hogan
ANC 1A03 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Mack James
ANC 1A04 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Anne Theisen
ANC 1A05 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Jenna Moheyer
ANC 1A06 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Ali Muhammad
ANC 1A07 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Janisha Richardson
ANC 1A08 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Lisa Eady
ANC 1A09 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Lenwood Johnson
ANC 1A10 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Dotti Love Wade
ANC 1A11 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Myla Moss
ANC 1B01 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Philip Spalding
ANC 1B02 Commissioner
P.O. Box 73710
Washington, DC 20009

Ms. Catherine Hammonds
ANC 1B03 Commissioner
P.O. Box 73710
Washington, DC 20009

Ms. Dee Hunter
ANC 1B04 Commissioner
P.O. Box 73710
Washington, DC 20009

Ms. Brianne Nadeau
ANC 1B05 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Meghan Conklin
ANC 1B06 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Zachary Wright
ANC 1B07 Commissioner
P.O. Box 73710
Washington, DC 20009

Ms. Rosemary Akinmboni
ANC 1B08 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Thomas Smith
ANC 1B09 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Nate Mathews
ANC 1B10 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Raymond Wright
ANC 1B11 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Alexander Padro
ANC 2C01 Commissioner
P.O. Box 26182, Ledroit Park Station
Washington, DC 20001

Mr.Kevin Chapple
ANC 2C02 Commissioner
P.O. Box 26182, Ledroit Park Station
Washington, DC 20001

Ms. Doris Brooks
ANC 2C03 Commissioner
P.O. Box 26182, Ledroit Park Station
Washington, DC 20001

Ms. Barbara Curtis
ANC 2C04 Commissioner
P.O. Box 26182, Ledroit Park Station
Washington, DC 20001

Ms. Dee Jolley
ANC 4C01 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Damian Nickens
ANC 4C02 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Ronald Bland
ANC 4C03 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Ms. Maggie Biscarr
ANC 4C04 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Louis Wassel
ANC 4C05 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Ms. Shanel Anthony
ANC 4C07 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Timothy Jones
ANC 4C08 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Joseph Martin, Jr.
ANC 4C09 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Kevin Hummons
ANC 4C10 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Joshua Lopez
ANC 4D01 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Renee Bowser
ANC 4D02 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Robert Whiddon
ANC 4D03 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Donna Brockington
ANC 4D04 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Mr. Everett Lott
ANC 4D05 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Lucretia Hockaday
ANC 4D06 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Mr. Anita Bonds
ANC 5C01 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Cleopatra Jones
ANC 5C02 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Stuart Davenport
ANC 5C03 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. John Salatti
ANC 5C04 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Aaron Knights
ANC 5C05 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Mary Farmer
ANC 5C06 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Barrie Daneker
ANC 5C07 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Marshall Phillips, Sr.
ANC 5C08 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Silas Grant
ANC 5C09 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Allison Defoe
ANC 5C11 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Derrick Holloway
ANC 5C12 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Peter Gray
Coalition for the Capital Crescent Trail
P.O. Box 30703
Bethesda, MD 20824

Ms. Myla Moss
President, LeDroit Park Civic Association
P.O. Box 135
Washington, DC 20044

Mr. Walter Smith, Executive Director
The DC Appleseed Center for Law and Justice, Inc.
1111 14th Street NW, Suite 510
Washington, DC 20005

Mr. Paul Schwartz
Clean Water Action
4455 Connecticut Ave NW, A300
Washington, DC 20008

Mr. Chris Weiss
Director, D.C. Environmental Network
1717 Massachusetts Avenue, NW, Suite 600
Washington, DC 20036

Executive Director
National Black Environmental Justice Network
P.O. Box 15845
Washington, DC 20003

Mr. George Sorvalis
Working Group on Community Right-to-Know
1742 Connecticut Ave., NW
Washington DC 20009

Mr. Elizabeth Sandza
ANC 3D01 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Tom Smith
ANC 3D02 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Nan Wells
ANC 3D03 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Ann Heuer
ANC 3D06 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Ann Haas
ANC 3D09 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Amy McVey
ANC 3E01 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Ms. Talia Primor
ANC 3E02 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Ms. Lucy Eldridge
ANC 3E04 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Ms. Anne Sullivan
ANC 3E05 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Honorable Adrian M. Fenty
Mayor of the District of Columbia
John A. Wilson Building
1350 Pennsylvania Avenue, N.W.
Washington, D.C. 20004

Honorable Harry Thomas, Jr.
Ward 5 Councilmember
John A. Wilson Building
1350 Pennsylvania Avenue, N.W., Suite 107Washington, D.C. 20004

Ms. Marie Sansone
Acting Senior Deputy Director
51 N Street NE, 6th Floor
Washington, DC 20002

Ms. Carolyn Sherman
ANC 3E03 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Mr. Paul Orum
Center for American Progress
PO Box 15465
Washington, DC 20003

TAB C

United States Department of the Interior

NATIONAL PARK SERVICE
George Washington Memorial Parkway
c/o Turkey Run Park
McLean, Virginia 22101

IN REPLY REFER TO:

L7600AAA (GWMP

MAY 1 5 2007

Mr. Thomas P. Jacobus
General Manager
Department of the Army
Washington Aqueduct
U.S. Army Corps of Engineers, Baltimore District
5900 MacArthur Boulevard, N.W.
Washington, D.C. 20016-2514

Dear Mr. Jacobus:

Thank you for the opportunity to review the draft environmental assessment (EA) for system improvements of the Dalecarlia Water Treatment Plant (WTP) and McMillian WTP for disinfection and pH control. The George Washington Memorial Parkway and Clara Barton Parkway, both units of the National Park Service, are situated near this project's site. In our responsibility of managing the Parkways' viewshed and natural and cultural resources, we want to ensure that the EA is explicit in addressing the following:

1. The new building on the Army base should not be visible from park land and should not be an adverse visual impact on the Potomac Gorge.

2. Contractors hauling the sodium hypochlorite or other chemicals cannot use either the Clara Barton Parkway or the George Washington Memorial Parkway.

3. The EA should require detailed safety measures and implementation plans for containment of spills resulting from pipeline breaks or the flushing of any residual chemicals into the Potomac River or the C & O Canal.

Thanks again for the opportunity to review and comment on this draft environmental assessment. Shoud you have any questions on this matter, please do not hesitate to contact my office at (703) 289-2500.

Sincerely,

David Vela
Superintendent

GOVERNMENT OF THE DISTRICT OF COLUMBIA
DISTRICT DIVISION OF TRANSPORTATION

★ ★ ★

Office of the Director

MAY - 3 2007

Mr. Thomas P. Jacobus, General Manager
Department of the Army, Washington Aqueduct
US Army Corps of Engineers, Baltimore District
5900 MacArthur Boulevard, N.W.
Washington, D.C. 20016

Dear Mr. Jacobus:

The District Department of Transportation (DDOT) has reviewed the Draft Environmental Assessment (EA) for system improvements of the Dalecarlia Water Treatment Plant (WTP) and McMillian WTP for disinfection and pH control. The Final Environmental Impact Statement included an analysis of potential impacts on area roads due to traffic associated with transporting water treatment chemicals and found that there were no significant impacts associated with the expected increase in traffic. DDOT concurs with this analysis and therefore, endorses the phasing-out of the use of liquid chlorine and replacing it with bulk aqueous sodium hypochlorite, which is a much safer alternative.

Please direct all questions to Mr. Kenneth Laden at 202-671-2309 or Ken.Laden@dc.gov.

Sincerely,

Emeka Moneme
Director

GOVERNMENT OF THE DISTRICT OF COLUMBIA
HISTORIC PRESERVATION OFFICE
OFFICE OF PLANNING

April 23, 2007

Mr. Thomas P. Jacobus
Department of the Army
U.S. Army Corps of Engineers, Baltimore District
5900 MacArthur Blvd NW
Washington DC 20016

RE: Draft Environmental Assessment, System Improvements at Dalecalria and McMillan WTPs

Dear Mr. Jacobus:

Thank you for submitting the draft Environmental Assessment for system improvements at the McMilllan Water Treatment Plant (WTP), which is a District of Columbia landmark and is considered eligible for listing in the National Register, and the Dalecarlia WTP, which is a National Historic Landmark.

The DC State Historic Preservation Office (SHPO) has reviewed the Draft EA and Appendices. Since the plans for new construction, including facility placement and design, are preliminary at this time, the SHPO has no comments on the draft. However, we look forward to the development of designs and appreciate the Army's willingness to minimize effects to archaeological resources, historic architecture, and settings of these two historic sites.

Thank you for providing this office the opportunity to comment. If you have any questions, please do not hesitate to call me at 202.442.8800.

Sincerely,

David Maloney
Acting State Historic Preservation Officer

20070134 8

DEPARTMENT OF THE ARMY
WASHINGTON AQUEDUCT
U.S. ARMY CORPS OF ENGINEERS, BALTIMORE DISTRICT
5900 MACARTHUR BOULEVARD, N.W.
WASHINGTON, D.C. 20016-2514

RECEIVED
APR 19 2007
By______

April 17, 2007

Office of the General Manager

F
COE
JES

Ms. Tania Tully, State Historic Preservation Officer
Maryland Historical Trust
Division of Historical and Cultural Programs
100 Community Place
Crownsville, MD 21032-2023

The Maryland Historical Trust has determined that this undertaking will have no adverse effect on historic properties.*
Andrew Lewis Date 4/27/07

Dear Ms. Tully:

MO Co. *Any proposed changes to historic structures should be submitted to the Trust for comment.

Washington Aqueduct has completed the Draft Environmental Assessment (EA) for system improvements of the Dalecarlia Water Treatment Plant (WTP) and McMillan WTP for disinfection and pH control. All of the alternatives considered in the Draft EA were associated with no anticipated significant adverse impacts. A preferred alternative was identified involving the phasing-out of the use of liquid chlorine and replacing it with bulk aqueous sodium hypochlorite, a much safer alternative. Additionally, the preferred alternative includes the incorporation of caustic soda at both facilities and sulfuric acid at the McMillan WTP into the pH control strategy in order to enhance the efforts to control corrosion in the distribution system drinking water.

I have enclosed a printed copy of the Draft EA. The appendices to the Draft EA can be downloaded from the project website:

http://washingtonaqueduct.nab.usace.army.mil/hypochlorite.htm

The Draft EA and the complete Administrative Record can be viewed at the Mt. Pleasant Branch or the Palisades Branch of the District of Columbia Public Library and at the Little Falls Branch of the Montgomery County Public Library.

Washington Aqueduct is soliciting information or comments applicable to the Draft EA. Any comments received will be considered in the preparation of the Final EA. Upon completion, the Final EA will be made available for public review. Comments must be submitted or postmarked by May 21, 2007.

Any questions can be directed to Mr. Michael Peterson at 202-764-0025 or michael.c.peterson@usace.army.mil.

Sincerely,

Thomas P. Jacobus
General Manager

Enclosure

M:29-49
- water treatment/storage facilities existing intrusions
- may be future consultation about slow sand filter bldgs
2cng
JES
4/23/07

MDE

MARYLAND DEPARTMENT OF THE ENVIRONMENT

1800 Washington Boulevard • Baltimore MD 21230
410-537-3000 • 1-800-633-6101

MAY 24 2007

Mr. Thomas P. Jacobus, General Manager
Department of the Army
Washington Aqueduct
U.S. Army Corps of Engineers, Baltimore District
5900 MacArthur Boulevard, N.W.
Washington, D.C. 20016-2514

Dear Mr. Jacobus:

Thank you for your correspondence forwarding the Draft Environmental Assessment (EA) for system improvements of the Dalecarlia and McMillan Water Treatment Plants. I appreciate the opportunity to respond to you regarding this important matter.

The Draft EA indicates that the scope of the project is limited to various system improvements at the existing plant sites hence none of the alternatives under consideration was identified as having any significant adverse impacts. Based on the nature, scope, and location of the project, the Department has no review comments to offer.

Thank you again for your letter. If I may be of any further assistance on this or any other matter, please do not hesitate to contact me or Virginia F. Kearney, Acting Director of Water Management Administration, at 410-537-3567, toll-free 800-633-6101, or via e-mail at vkearney@mde.state.md.us.

Very truly yours,

Shari T. Wilson

Shari T. Wilson
Secretary

cc: Virginia F. Kearney, Acting Director of Water Management Administration
Maryland Department of the Environment (MDE)

MONTGOMERY COUNTY PLANNING DEPARTMENT
THE MARYLAND-NATIONAL CAPITAL PARK AND PLANNING COMMISSION

May 11, 2007

Thomas P. Jacobus
General Manager
Washington Aqueduct
U.S. Army Corps of Engineers
5900 MacArthur Boulevard, N.W.
Washington, D.C. 20016-2514

Dear Mr. Jacobus:

Thank you for the opportunity to review the *Draft Environmental Assessment (EA) for system improvements of the Dalecarlia Water Treatment Plant (WTP) and McMillan WTP for disinfection and pH control*. Because the McMillan WTP is located within the District of Columbia, we confined our review of the EA to the portion that deals with the Dalecarlia WTP. We offer the following comments.

M-NCPPC Transportation Planning staff concur with the Draft Environmental Assessment conclusion that none of the alternatives would have a significant adverse effect on the adjacent transportation system. While changes in operational conditions are not typically assessed from a Local Area Transportation Review (LATR) perspective, the magnitude of the proposed change is minor. As indicated in Table 2-2 of the EA, the proposed alternative would increase the number of truck deliveries to the Dalecarlia WTP by up to 30 deliveries per month.

From an LATR perspective, proposed projects that generate more than 30 vehicle trips during the weekday peak <u>hour</u> are assumed to have an impact on area roadway congestion requiring further study. Each delivery is composed of two truck trips (arriving and departing). The proposed 60 additional trips per <u>month</u> equates to less than one trip per hour on the average. We therefore find that the proposed impact will not have a significant impact on traffic congestion. However, we do support the consultant recommendation in the Draft EA Appendix F to encourage deliveries to occur during weekday midday periods (between the morning and evening peak travel periods) to minimize time delay for the truck trips and, therefore, any associated fuel consumption and emissions.

M-NCPPC Park staff reviewed the EA for possible impacts to parkland and the nearby Capital Crescent Trail, and found no issues of concern. However, it is strongly recommended that the Coalition for the Capital Crescent Trail, a private volunteer organization, be informed of this project as early as possible, and kept apprised of future developments and decisions.

If you have any questions, please contact Jorge A. Valladares, P.E., Chief, Environmental Planning at (301) 495-4545, or me at (301) 495-4636.

Sincerely,

Mark A. Symborski

Mark A. Symborski
Planner Coordinator
Environmental Planning
Countywide Planning Division

MS:ss

cc: Royce Hanson
Gwen Wright
Mary Bradford
Mary Dolan
Jorge Valladares
Rick Hawthorne
John Hench
Dan Hardy
Lyn Coleman

From: Bullo, Ibrahim (DDOE) [ibrahim.bullo@dc.gov]
Sent: Monday, May 21, 2007 1:19 PM
To: Peterson, Michael C WAD
Cc: Inge, Rosalind (DDOE); Ebanks, Edna (DDOE)
Subject: DRAFT ENVIRONMENTAL ASSESSMENT (EA) FOR SYSTEM IMPROVEMENTSOF THE DALECARLIA WTP AND McMILLAN WTP

The District of Columbia Department of the Environment (DDOE) understands that the Draft EA presents alternatives for enhancing the drinking water disinfection and pH control processes at the McMillan and Dalecarlia reservoirs. The Draft EA states that the use, handling and storage of the "chemicals can be managed through proper engineering and management controls, minimizing or eliminating the potential for impacts" (section 4.1.9). The Draft EA also states, as part of the storm water management at the facilities, "new controls would be designed to mitigate any potential impacts" (section 4.1.3). Since precipitation falling on the site drains either to the District of Columbia storm sewer system or to the respective reservoirs, DDOE strongly recommends that a spill prevention and emergency response plan be instituted as part of the implementation of the proposed alternative.

Ibrahim Bullo

Environmental Review Coordinator/

Interim FOIA Officer/

Environmental Justice Coordinator

District Department of the Environment

51 N Street, NE

Room 5020

Washington, DC 20002

Phone: (202) 535 2506

Fax: (202) 535-2881

CENAB-WA-EN 9 MARCH 2007

MEMORANDUM FOR RECORD

SUBJECT: Scoping Comments Regarding System Improvements of the Dalecarlia WTP and McMillan WTP for Disinfection and pH Control

1. In order to solicit information from specific individuals, groups, elected officials, agencies, and the general public regarding an Environmental Assessment for System Improvements of the Dalecarlia WTP and McMillan WTP for Disinfection and pH Control, Washington Aqueduct prepared a Public Notice (attached at Tab A) published in several newspapers (*Washington Post* [June 15, 2006], *Northwest Current* [June 14, 2006], *Bethesda Gazette* [June 14, 2006], *Washington Afro-American Newspaper* [June 17, 2006], *The Common Denominator* [June 12, 2006]) and mailed directly (list and copies of cover letters are attached at Tab B). On June 11, 2007, the Public Notice and the direct mail list were available on the project website (http://washingtonaqueduct.nab.usace.army.mil/hypochlorite.htm).

2. Washington Aqueduct received three separate letters containing formal scoping comments: from the Maryland State Highway Administration; from a group of neighbors of the Dalecarlia Water Treatment Plant; and from Congressman Chris Van Hollen, who represents constituents in Maryland living near the Dalecarlia Water Treatment Plant and transportation routes commonly used for deliveries to Dalecarlia. Copies of these letters are attached (at Tabs C, D, and E, respectively).

a. The Maryland State Highway Administration acknowledged their interest in safety on roadways in Maryland, which they indicated would be improved by a transition from liquid chlorine (compressed chlorine gas) to aqueous sodium hypochlorite, even when considering a potential increase in the overall number of deliveries. The agency also suggested consideration of deliveries during off-peak hours and at night as feasible. The agency also offered to provide information on the transportation of hazardous materials.

b. The neighborhood group requested that two separate Environmental Impact Statements be developed for the NEPA evaluation of the conversion to aqueous sodium hypochlorite as well as the conversion to use of caustic soda as part of the overall pH control system for the Washington Aqueduct. The group listed several factors listed by the Council of Environmental Quality in NEPA guidance documents that would indicate a need for evaluation within an Environmental Impact Statement. The group requested an opportunity to be involved in developing screening criteria if an Environmental Impact Statement were to be developed. The group also requested answers to several specific questions as presented (with accompanying responses) in Table 1.

c. Congressman Chris Van Hollen concurred with the comments from the Dalecarlia neighborhood group and included a copy of the letter that they submitted directly to the Washington Aqueduct. Mr. Van Hollen requested development of an Environmental Impact Statement based on the same factors listed by the group.

MICHAEL C. PETERSON
Environmental Engineer

Table 1. Scoping comments and corresponding responses for the System Improvements of the Dalecarlia WTP and McMillan WTP for Disinfection and pH Control Environmental Assessment.

Comment	*Response*
What are the safety risks to residents from the delivery, storing, usage, or cleaning of Aqueous Sodium Hypochlorite and Caustic Soda?	Safety risks to residents related to the delivery, storage, and use of aqueous sodium hypochlorite are not expected to be significant. In contrast to the delivery, storage and use of liquid chlorine, aqueous sodium hypochlorite is much safer, and requires substantially fewer engineering and management controls to ensure safety. Aqueous sodium hypochlorite is also known as bleach. The concentration of household bleach is typically about 5%. The concentration of bleach potentially used for disinfecting drinking water by the Washington Aqueduct ranges from 0.8% to 12% (final chlorine concentrations for disinfection in drinking water are much lower than these concentrations). All appropriate measures will be taken to ensure the safety of anyone who could possibly come into contact with the chemical; however this will primarily be expected to include employees of the Washington Aqueduct. *Pamphlet 96: Sodium Hypochlorite Manual*, has been included in the Administrative Record for the Draft Environmental Assessment and includes discussion of specific safety considerations and design requirements for the use of aqueous sodium hypochlorite. Safety risks to residents related to the delivery, storage and use of caustic soda are also not expected to be significant. Caustic soda is a hazardous substance, and is more hazardous in handling than lime, which is currently used by the Washington Aqueduct. However, it is a chemical that is widely used in the water treatment industry. Additionally, based on new regulatory requirements from the United States Environmental Protection Agency related to the control of corrosion in the drinking water distribution system for the District of Columbia, the use of caustic soda is now necessary at the Washington Aqueduct. The tighter control of pH in drinking water will improve the ability of the Washington Aqueduct to minimize potential corrosion, and therefore reduce the possibility of the leaching of lead and other metals in the distribution system. All appropriate measures will be taken to ensure the safety of anyone who could possibly come into contact with the chemical; however this will primarily be expected to include employees of the Washington Aqueduct. Safety measures will also include specifying the appropriate safety controls for delivery vehicles and training for drivers.
What are the plans for using or disposing of excess bulk liquid chlorine?	The liquid chlorine at the Washington Aqueduct will either be used or returned to the vendor that originally supplied it. The vendor routinely delivers and picks-up used chlorine cylinders from the Washington Aqueduct facilities. Typically a small percentage of liquid chlorine remains in the cylinder when it has been used and is being returned to the vendor.
What impact will the additional trucks have on ambient noise levels as they travel neighborhood roads and within the McMillan and Dalecarlia facilities? What routes will the trucks travel? What hours will the truck travel: During rush hour? During school bus hours? Will trucks incorporate alternate clean burning fuels? Will truck sizes be limited for the residential roads?	With the proposed action and the preferred alternative, the number of trucks to be used for delivering disinfection and pH control chemicals is expected to increase compared to the current conditions. However, the increased number of deliveries to Washington Aqueduct facilities is not expected to significantly increase ambient noise levels on roads as the delivery vehicles will be similar to other types of traffic already using the roads. The routes that the trucks will take will be similar to the routes that are currently used for deliveries. There are no established truck routes in the District of Columbia, however if these are established in the future they will necessarily be used. In the State of Maryland, only state highways or interstate highways are expected to be used by trucks making deliveries to Washington Aqueduct facilities. Truck size and type will be the standard used for the appropriate application, such as a tanker truck for delivering bulk aqueous sodium hypochlorite. Deliveries will likely be made by vendors during off-peak hours in order to minimize costs associated with delays during rush-hour, which is likely to coincide with the morning school bus hours, but not necessarily the afternoon school bus hours. The need for placing contract restrictions on the vendors is not expected to be necessary due to the low number of deliveries anticipated and the contractor desire to minimize their costs. As new regulations related to pollution controls are established, including for the use of low sulfur fuels, Washington Aqueduct will adapt contract language to ensure regulations are followed by vendors.
Will trees be cleared to build or expand the facilities? What air quality and noise impacts will the new or expanded facilities have on neighbors and the Capital Crescent Trail?	At the Dalecarlia WTP, one ornamental tree is expected to need to be removed in order to construct a new facility. There are no affected trees at the McMillan WTP. The potential air quality impacts associated with the proposed project are expected to be below the *de minimis* thresholds. The minimization of potential noise sources will be an objective during the design of the facility, however sounds from activities related to the proposed project will be similar to types of sounds evident from the existing facilities. Based on these considerations, there is not expected to be a significant impact on air quality and noise to neighboring residences, businesses, or Capital Crescent Trail users.
We request that an Environmental Impact Assessment ("EIS"), not an Environmental Assessment, be conducted on these proposals. Further, we request that the projects be separated into two Environmental Impact Assessments with one covering the Disinfection improvements and the second covering the pH Control. We believe that a project that considers the expansion or building of facilities at the Dalecarlia Water Treatment Plant requires an EIS because it may alter the character of existing residential areas, adversely affect a floodplain, have significant adverse effect on parklands and other public lands in the form of the National Capital Crescent Trail, and have a significant adverse effect upon local ambient air quality and local ambient noise levels. As we have requested with past Environmental Impact Assessments, we would like residents to have the opportunity to participate fully in the NEPA process starting with an opportunity to participate in the development of the screening criteria for these two projects.	The NEPA analyses for potential system modification for disinfection and pH control are presented simultaneously in the Draft Environmental Assessment because of the direct influence of the disinfection process on pH control, and the converse influence. As described in the Feasibility Study in the Appendix of the Draft Environmental Assessment, our consultant used a computer model and bench scale laboratory analysis to analyze the complicated series of chemical reactions influencing pH from the water treatment process, including with the disinfection step. Because aqueous sodium hypochlorite increases the pH of water when it is added for disinfection at the Washington Aqueduct, the amount (and type) of chemical needed to modify pH necessarily would change with a potential transition from the use of liquid chlorine. It is necessary, therefore, when making a decision regarding a change in the disinfection process to simultaneously make a decision regarding the corresponding necessary changes to the pH control system. It is appropriate, therefore, to present the decision-making process for these possible system modifications for the Washington Aqueduct in a single NEPA document. In the event that significant adverse impacts were expected to any resource (such as to floodplains, parklands, residential areas, other public lands of recognized scenic and recreational value, local ambient air quality and noise levels) associated with a project, preparation of an Environmental Impact Statement would be required. However, for the proposed action, no significant adverse impacts are expected based on analysis as described in the Environmental Assessment. Therefore preparation of an Environmental Impact Statement is not appropriate for this particular proposed action. With the preferred alternative there are some real benefits and real opportunities for future benefits – firstly and most importantly with the elimination of the delivery, storage and use of liquid chlorine, an extremely hazardous material, and the potential future opportunity for generation of disinfectant materials on-site with serious cost benefits and reduction in required deliveries to Washington Aqueduct facilities. It is fortunate that the capital investments in using bulk hypochlorite can be converted in the event that on-site generation of aqueous sodium hypochlorite were to be implemented in the future. The immediate elimination of liquid chlorine is important enough to implement the use of bulk aqueous sodium hypochlorite delivery, storage and use at least in the interim while the viability of on-site hypochlorite for the Washington Aqueduct is fully investigated.

TAB A

PUBLIC NOTICE

Environmental Assessment – Proposed System Improvements of the Dalecarlia WTP and the McMillan WTP for Disinfection and pH Control

Washington Aqueduct, Washington, DC

Washington Aqueduct, a Division of the U.S. Army Corps of Engineers (USACE), Baltimore District, operates the Dalecarlia and McMillan Water Treatment Plants (WTPs) in Washington, D.C., serving potable water to over one million persons in the District of Columbia and northern Virginia. The treatment process removes solid particles from the Potomac River supply water, treats and disinfects the water, and distributes the finished water to the metropolitan service area. Washington Aqueduct is considering modification of two components of the treatment process – disinfection and control of pH – at both the Dalecarlia WTP and the McMillan WTP to enhance the reliability of the production of safe drinking water and to reduce operational risk. Washington Aqueduct is preparing an Environmental Assessment (EA) on the proposed system modification.

Bulk liquid chlorine, created by compressing pure chlorine gas, has been used throughout the history of disinfection at the Dalecarlia WTP and the McMillan WTP. Due to the hazardous nature of the liquid chlorine, engineering and management controls are employed to minimize risks associated with its handling and use. As an alternative to using liquid chlorine, chlorine as aqueous hypochlorite, an inherently safer form, is commercially available and frequently used in the water treatment industry. Washington Aqueduct is considering converting the disinfection process at the Dalecarlia WTP and the McMillan WTP from using bulk liquid chlorine to using aqueous hypochlorite for disinfection in order to eliminate the inherent risks associated with storing and handling liquid chlorine.

Conversion to a hypochlorite disinfection system would involve modification of existing structures at the Dalecarlia WTP and the McMillan WTP, potentially resulting in expansion of these structures, or in construction of new structures depending on how the conversion would be implemented. If this conversion is selected, deliveries and storage of liquid chlorine would be replaced with deliveries and storage of aqueous hypochlorite, resulting in a net increase in deliveries depending on how the conversion would be implemented. The potential for a rapid concentrated release of gaseous chlorine would be eliminated by implementation. Aqueous hypochlorite and liquid chlorine provide an equivalent level of disinfection of drinking water. Based on current market values, the cost of using hypochlorite is greater than that for liquid chlorine.

In 2004, in the interest of managing corrosion observed in parts of the District of Columbia water distribution system, the United States Environmental Protection Agency approved a Washington Aqueduct plan to take steps to modify the water treatment process. The initial step taken was to introduce a chemical corrosion inhibitor. In addition, the acceptable range for pH in finished water was modified.

Washington Aqueduct is currently considering implementing a process called caustic soda trimming, which would involve installing new equipment and utilizing caustic soda as a measure to allow for added operational precision in the control of pH, increasing the system reliability to achieve pH values in the acceptable range. The existing system using lime would not be abandoned, but caustic soda trimming would serve as a redundant system for both facilities and would also allow for a more precise finishing step in control of pH levels. If selected, the proposed new equipment for caustic soda trimming would be installed in the same facilities that would house the proposed new aqueous hypochlorite system. Adding the caustic soda process would also necessitate an increase in chemical deliveries to both the Dalecarlia WTP and McMillan WTP. If selected, the cost of using the caustic soda would likely be additive to the cost associated with the existing lime process.

A list of the federal, state, and local agencies with which the Corps is coordinating is available on the project website (URL is shown below), or upon request. Washington Aqueduct is soliciting information from the public applicable to the proposed action. Any comments received will be considered in the preparation of the EA. Upon completion, the EA will be made available for public review. Comments must be submitted or postmarked by July 17, 2006. Contact information is shown below.

For further information, please contact the
Washington Aqueduct NEPA Coordinator
at the address shown, at 202-764-0025 or at
washingtonaqueduct@usace.army.mil

U.S. Army Corps of Engineers
Baltimore District, Washington Aqueduct
5900 MacArthur Boulevard NW
Washington, D.C. 20016-2514

Website: http://washingtonaqueduct.nab.usace.army.mil/

TAB B

Mr. William O. Howland, Director
D.C. Department of Public Works
2000 14th Street, NW
Washington, DC 20001

Ms. Michelle L. Pourciau, Acting Director
D.C. Department of Transportation
2000 14th Street, NW, 6th Floor
Washington, DC 20001

Mr. Tom Henderson, Administrator
Solid Waste Management
D.C. Department of Public Works
2000 14th Street, NW
Washington, DC 20001

Mr. John Wolflin, Field Supervisor
Chesapeake Bay Field Office
U.S. Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401

Mr. Joseph Lawler, Director
National Capital Region
National Park Service
1100 Ohio Drive, SW
Washington, DC 20242

Mr. Eric W. Price
Office of the Deputy Mayor for Planning and Economic Development
John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 317
Washington, DC 20004

Mr. Robert Spagnoletti
Attorney General for the District of Columbia
1350 Pennsylvania Avenue, NW
Suite 409
Washington, DC 20004

Mr. Douglas M. Duncan, County Executive
Executive Office Building
101 Monroe Street
Rockville, MD 20850

Honorable Christopher Zimmerman
Arlington County Board
2100 Clarendon Boulevard, Suite 300
Arlington, VA 22201

Mr. Don L. Klima, Director
Office of Federal Agency Programs
Advisory Council on Historic Preservation
1100 Pennsylvania Avenue, NW, Suite 803
Washington, DC 20004

Adrian H. Thompson, Chief
District of Columbia Fire and Emergency Medical Services
1923 Vermont Avenue, NW
Washington, DC 20001

Charles H. Ramsey, Chief of Police
Metropolitan Police Department
Government of the District of Columbia
300 Indiana Avenue, NW
Washington, DC 20001

Mr. David J. Robertson
Executive Director
Metropolitan Washington Council of Governments
777 North Capitol Street, NE, Suite 300
Washington, DC 20002-4201

Mr. Robert M. Summers, Director
Water Management Administration
Maryland Department of the Environment
1800 Washington Boulevard
Baltimore, MD 21230

Honorable Carol Schwartz
Chair, Committee on Public Works and the Environment
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 111
Washington, DC 20004

Mr. Ron Carlee, County Manager
Arlington County
1 Courthouse Plaza
2100 Clarendon Boulevard
Arlington, VA 22201

Ms. Patricia E. Gallagher
Executive Director
National Capital Planning Commission
401 9th Street, NW, Suite 500
Washington, DC 20576

Mr. Ken Chandler, Acting Director
Department of Environmental Services
1 Courthouse Plaza
2100 Clarendon Boulevard, Suite 900
Arlington, VA 22201

Ms. Lisa Burcham, State Historic Preservation Officer
Historic Preservation Division
D.C. Office of Planning
801 North Capitol Street, NE, Suite 4000
Washington, DC 20002

Ms. Lucia Leith
Western Avenue Citizens Association
4626 Western Avenue
Bethesda, MD 20816

Mr. James A. Caldwell, Director
Montgomery County Government
Department of Environmental Protection
255 Rockville Pike
Rockville, MD 20850

Mr. Arthur Holmes, Jr., Director
Montgomery County Department of Public Works and Transportation
101 Monroe Street; 10th Floor
Rockville, MD 20850-2450

Honorable Howard A. Denis
District 1 Councilmember
Montgomery County Council
100 Maryland Avenue
Rockville, MD 20850

Mr. Jerry N. Johnson
General Manager
D.C. Water and Sewer Authority
5000 Overlook Avenue, SW
Washington, DC 20032

Mr. Neil O. Albert, Director
D.C. Parks and Recreation Department
3149 16th Street, NW
Washington, DC 20010

Mr. Daniel McKeever
City Manager
City of Falls Church
300 Park Avenue
Falls Church, VA 22046

Honorable Daniel E. Gardner
Mayor, City of Falls Church
300 Park Avenue
Falls Church, VA 22046

Honorable Paul S. Sarbanes
309 Hart Senate Office Building
U.S. Senate
Washington, DC 20510

Mr. Burton Gray, President
Cabin John Citizens Association
PO Box 31
Cabin John, MD 20818

Mr. Jerry L. Price
Chief Operating Officer
Sibley Memorial Hospital
5255 Loughboro Road, NW
Washington, DC 20016-2695

Ms. Deborah R. Thomas, Chair
ANC 1B
P.O. Box 73710
Washington, DC 20009

Honorable Eleanor Holmes Norton
United States House of Representatives
2136 Rayburn House Office Building
Washington, DC 20515

Mr. William S. Spencer, President
Palisades Citizens Association
2825 49th St NW
Washington, DC 20007-1010

Ms. Rachel W. Thompson
ANC 3D Commissioner
5835 Sherier Place, NW
Washington, DC 20016-5323

Mr. Thomas Luebke, Secretary
U.S. Commission of Fine Arts
National Building Museum
401 F Street, NW, Suite 312
Washington, DC 20001-2728

Mr. Dean F. Amel, Chair
Arlington County Environment and Energy Conservation Commission
3013 N. 4th St.
Arlington, VA 22201

Mr. Kevin Brandt, Superintendent
C&O Canal NHP Headquarters
1850 Dual Highway, Suite 100
Hagerstown, MD 21740

Ms. Alma H. Gates
Chair, ANC 3D
PO Box 40846
Palisades StationWashington, DC 20016

Mr. Ron Tripp
Citizens' Coordinating Committee on Friendship Heights
5330 Sherrill Ave
Chevy Chase, MD 20815

Mr. Erik D. Olson
NRDC
1200 New York Avenue, NW, Suite 400
Washington, DC 20005

Honorable Jim Graham
Councilmember Ward 1
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 105Washington, DC 20004

Honorable Jack Evans
Ward 2 Councilmember
John A. Wilson Building
1350 Pennsylvania Avenue, NW, Room 106
Washington, DC 20004

Mr. David Brewster
Office of Maryland Senator Brian Frosh
446 Miller Senate Office Building
Annapolis, MD 21401-1991

Honorable Kathy Patterson
Councilwoman Ward 3
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 107
Washington, DC 20004

Ms. Brenda Creel, General Manager for Environmental Services
City of Falls Church
300 Park Avenue
Falls Church, VA 22046

Mr. Peter Rousselot, Chair
Arlington County Fiscal Affairs Advisory Commission
3182 Key Boulevard
Arlington, Virginia 22201

Ms. Tania Tully, State Historic Preservation Officer
Maryland Historical Trust
Division of Historical and Cultural Programs
100 Community Place

Ms. Debra Graham
Westmoreland Citizens Association
5407 Duvall Drive
Bethesda, MD 20816

Mr. Lucian Pugliaresi
Spring Valley-Wesley Heights Citizens Association
c/o LPI Consulting, Inc.
1031 31st Street, NW
Washington, DC 20007

Mr. Barry Lucas
DCWASA - DETS
5000 Overlook Ave., SW
Washington, DC 20032

Mr. Raymond Roach
Washington DC Regional Office
Natural Resources Defense Council
1200 New York Ave., NW, Suite 400
Washington, DC 20005

Honorable Chris Van Hollen
United States House of Representatives
1419 Longworth House Office Building
Washington, DC 20515

Honorable Jim Moran
United States House of Representatives
2239 Rayburn Building
Washington, DC 20515-4608

Mr. George S. Rizzo
Mail Code: 3WP22
U.S. EPA Region III
1650 Arch Street
Philadelphia, PA 19103-2029

Mr. William S. Arguto
U.S. EPA Region III
Mail Code: 3EA30
1650 Arch Street
Philadelphia, PA 19103-2029

Ms. Mary Letzkus
U.S. EPA Region III
Mail Code: 3WP13
1650 Arch Street
Philadelphia, PA 19103-2029

Ms. Lori Byrne, Environmental Review Specialist
MD DNR - Wildlife and Heritage Service
Tawes State Office Building, E-1
580 Taylor AvenueAnnapolis, MD 21401

Ms. Elizabeth Adams
Westmoreland Citizens Association
5111 Dalecarlia Drive
Bethesda, MD 20816

Honorable Barbara A. Mikulski
509 Hart Senate Office Building
U.S. Senate
Washington, D.C. 20510

Ms. Tanya Tomasko Spano
Department of Environmental Programs
Metropolitan Washington Council of Governments
777 North Capitol Street, NE
Washington, DC 20002-4226

Ms. Sherry Krest
Chesapeake Bay Field Office
U.S. Fish and Wildlife Service
177 Admiral Cochrane DriveAnnapolis, MD 21401

Honorable David A. Catania
Councilmember-At-Large
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 110Washington, DC 20004

Honorable Phil Mendelson
Councilmember-At-Large
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 402
Washington, DC 20004

Honorable Kwame R. Brown
Councilmember-At-Large
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 406Washington, DC 20004

Ms. Deborah J. Snead, Director
Bethesda-Chevy Chase
Regional Services Center
4805 Edgemoor Lane
Bethesda, MD 20814

Honorable Thomas E. Perez, Council President
Montgomery County Council
Stella B. Werner Council Office Building
100 Maryland AvenueRockville, MD 20850

Mr. Neil J. Pedersen, Administrator
Mail Stop C-400
State Highway Administration
P.O. Box 717
Baltimore, MD 21203-0717

Ms. Norma Danis Spiegel, President
Glen Echo Heights Citizens Association
5305 Wapakoneta Road
Bethesda, MD 20816

Ms. Faroll Hamer, Acting Director
Montgomery County Department of Park & Planning, MNCPPC
8787 Georgia Avenue
Silver Spring, MD 20910

Mr. Jon James, Acting Superintendent
George Washington Memorial Parkway
Turkey Run Park
McLean, VA 22101

Mr. Arrigo Mongini, President
Mohican Hills Citizens’ Association
5541 Mohican Road
Bethesda, MD 20816

Ms. Mary E. Fowler, President
Sumner Village Community Association
4974 Sentinel Drive, #102
Bethesda, MD 20816

Ms. Elizabeth Berry, Acting Director
District Department of the Environment
51 N Street NE, 6th Floor
Washington, DC 20002

Mr. Glen A. Smith
Regional Planner
Regional and Intermodal Planning Division
Maryland State Highway Administration
707 N. Calvert St - C-502
Baltimore, MD 21202

Mr. John Gill, President
Sumner Citizens' Association
5124 Baltan Road
Bethesda, MD 20816

Ms. Phyllis R. Edelman, President
Springfield Civic Association
P.O. Box 644
Glen Echo, MD 20815

Honorable Nancy Floreen
At-Large Councilmember
100 Maryland Ave, 6th Floor
Rockville, MD 20850

Mr. Derick P. Berlage
Chairman, Montgomery County Planning Board
8787 Georgia Avenue
Silver Spring, MD 20910

Mr. Stephen E. Baldwin
Western Montgomery County Citizens Advisory Board
6422 Kenhowe Drive
Bethesda, MD 20817

Ms. Lisa Vita
Zoning Committee, Springfield Civic Association
5904 Searl Terrace
Bethesda, MD 20816

Mr. Nasser M. Kamazani
Montgomery County Department of Environmental Protection
Watershed Management Division
255 Rockville Pike, Suite 120Rockville, MD 20850-4166

Ms. Jacqueline Arguelles
ANC 1A01 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Calvin Woodland
ANC 1A02 Commisioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Alexander Hogan
ANC 1A03 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Mack James
ANC 1A04 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Anne Theisen
ANC 1A05 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Jenna Moheyer
ANC 1A06 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Ali Muhammad
ANC 1A07 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Janisha Richardson
ANC 1A08 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Lisa Eady
ANC 1A09 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Mr. Lenwood Johnson
ANC 1A10 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Dotti Love Wade
ANC 1A11 Commissioner
P.O. Box 73115
Washington, DC 20056-3115

Ms. Myla Moss
ANC 1B01 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Philip Spalding
ANC 1B02 Commissioner
P.O. Box 73710
Washington, DC 20009

Ms. Catherine Hammonds
ANC 1B03 Commissioner
P.O. Box 73710
Washington, DC 20009

Ms. Dee Hunter
ANC 1B04 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Michael Smith
ANC 1B05 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Tim Stephens
ANC 1B06 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Zachary Wright
ANC 1B07 Commissioner
P.O. Box 73710
Washington, DC 20009

Ms. Rosemary Akinmboni
ANC 1B08 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Thomas Smith
ANC 1B09 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Nate Mathews
ANC 1B10 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Raymond Wright
ANC 1B11 Commissioner
P.O. Box 73710
Washington, DC 20009

Mr. Alexander Padro
ANC 2C01 Commissioner
P.O. Box 26182, Ledroit Park Station
Washington, DC 20001

Mr. Leroy Thorpe, Jr.
ANC 2C02 Commissioner
P.O. Box 26182, Ledroit Park Station
Washington, DC 20001

Ms. Doris Brooks
ANC 2C03 Commissioner
P.O. Box 26182, Ledroit Park Station
Washington, DC 20001

Ms. Barbara Curtis
ANC 2C04 Commissioner
P.O. Box 26182, Ledroit Park Station
Washington, DC 20001

Mr. Harold Prince
ANC 4C01 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Ken Alexander
ANC 4C02 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Ronald Bland
ANC 4C03 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Marc Yesberger
ANC 4C04 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Franklin Pryor
ANC 4C05 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Peron Williams
ANC 4C06 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Ms. Shanel Anthony
ANC 4C07 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Timothy Jones
ANC 4C08 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Joseph Martin, Jr.
ANC 4C09 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Joseph Henson
ANC 4C10 Commissioner
P.O. Box 60847
Washington, DC 20039-0847

Mr. Keith Jackson
ANC 4D01 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Renee Bowser
ANC 4D02 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Tina Thompson
ANC 4D03 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Arnyce Adams
ANC 4D04 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Audrey Hendricks
ANC 4D05 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Ms. Lucretia Hockaday
ANC 4D06 Commissioner
143 Kennedy Street, NW
Washington, DC 20011

Mr. James Berry, Jr.
ANC 5C01 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Cleopatra Jones
ANC 5C02 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Tom Fulton
ANC 5C03 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Robert Brannum
ANC 5C04 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Bertha Johnson
ANC 5C05 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Mary Farmer
ANC 5C06 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Celia Barnes
ANC 5C07 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Marshall Phillips, Sr.
ANC 5C08 Commissioner
P.O. Box 77761
Washington DC 20013

Ms. Debbie Smith
ANC 5C09 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. William Jentarra
ANC 5C11 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Derrick Holloway
ANC 5C12 Commissioner
P.O. Box 77761
Washington DC 20013

Mr. Peter Gray
Coalition for the Capital Crescent Trail
P.O. Box 30703
Bethesda, MD 20824

Ms. Myla Moss
President, LeDroit Park Civic Association
P.O. Box 135
Washington, DC 20044

Mr. Walter Smith, Executive Director
The DC Appleseed Center for Law and Justice, Inc.
1111 14th Street NW, Suite 510
Washington, DC 20005

Mr. Paul Schwartz
Clean Water Action
4455 Connecticut Ave NW, A300
Washington, DC 20008

Mr. Chris Weiss
Director, D.C. Environmental Network
1717 Massachusetts Avenue, NW, Suite 600
Washington, DC 20036

Executive Director
National Black Environmental Justice Network
P.O. Box 15845
Washington, DC 20003

Mr. George Sorvalis
Working Group on Community Right-to-Know
1742 Connecticut Ave., NW
Washington DC 20009

Mr. Hugh Mullane
ANC 3D01 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Sarah Shapley
ANC 3D02 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Jill Stern
ANC 3D03 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Ann Heuer
ANC 3D06 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Mr. Carl Ross
ANC 3D08 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Ann Haas
ANC 3D09 Commissioner
P.O. Box 40846 Palisades Station
Washington, DC 20016

Ms. Amy McVey
ANC 3E01 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Ms. Amy Hoang
ANC 3E02 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Ms. Lucy Eldridge
ANC 3E04 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Ms. Anne Sullivan
ANC 3E05 Commissioner
c/o Lisner Home, Suite #219
Washington, DC 20016

Honorable Adrian M. Fenty
Ward 4 Councilmember
John A. Wilson Building
1350 Pennsylvania Avenue, N.W., Suite 408Washington, D.C. 20004

Honorable Vincent B. Orange, Sr.
Ward 5 Councilmember
John A. Wilson Building
1350 Pennsylvania Avenue, N.W., Suite 408
Washington, D.C. 20004

Ms. Marie Sansone
Acting Senior Deputy Director
51 N Street NE, 6th Floor
Washington, DC 20002

DEPARTMENT OF THE ARMY
WASHINGTON AQUEDUCT
U.S. ARMY CORPS OF ENGINEERS, BALTIMORE DISTRICT
5900 MACARTHUR BOULEVARD, N.W.
WASHINGTON, D.C. 20016-2514

June 9, 2006

Office of the General Manager

Honorable Jim Graham
Councilmember Ward 1
The John A. Wilson Building
1350 Pennsylvania Avenue, NW, Suite 105
Washington, DC 20004

Dear Mr. Graham:

Washington Aqueduct is considering modification of two components of the treatment process at both the Dalecarlia and McMillan Water Treatment Plants to enhance the reliability of the production of safe drinking water and to reduce operational risk. Specifically, Washington Aqueduct is looking to convert facilities to use aqueous hypochlorite instead of bulk liquid chlorine (which is compressed chlorine gas) for disinfection, and to incorporate the use of caustic soda for more precise control of pH supplementing the current use of lime. If selected, both of these changes would result in an increase in deliveries of chemicals to both treatment plants. In addition, if selected, both alternatives might result in expansion of existing facilities or construction of new facilities within existing Washington Aqueduct property lines.

An environmental assessment (EA) will be initiated with the publication of the enclosed public notice in order to fully evaluate potential impacts associated with the proposed action. Washington Aqueduct is soliciting information from the public applicable to the proposed action. Any comments received will be considered in the preparation of the EA. Comments may be submitted to Washington Aqueduct as outlined in the public notice.

A list of the federal, state and local agencies that have been sent the notice is also enclosed with this letter.

Any questions can be directed to Mr. Michael Peterson at 202-764-0025 or michael.c.peterson@usace.army.mil.

Sincerely,

Thomas P. Jacobus
General Manager

Enclosure

TAB C

→ ENGR

June 28, 2006

Thomas P. Jacobus, General Manager
Department of the Army
Washington Aqueduct
U.S. Army Corps of Engineers, Baltimore District
5900 MacArthur Boulevard, NW
Washington, DC 20016-2514

J July 5

Dear Mr. Jacobus:

Thank you for your letter regarding the Washington Aqueduct's anticipated change in operations and shipping requirements. We appreciate your request for our review and comments and assure you that safety is the first and foremost priority of the State Highway Administration (SHA). A recent telephone conversation with Mr. Michael Peterson, with the U.S. Army Corps of Engineers, identified some additional information not contained in your June 9 letter. We understand the planned processing change will affect both your Dalecarlia and McMillan Water Treatment Plants. The McMillan Plant is located entirely in D.C., whereas the Dalecarlia Plant is situated in D.C. and Montgomery County, Maryland. Trucks supplying your chemicals will therefore be traveling through Maryland. The anticipated increase in demand for these chemical shipments is from two or three shipments per week at the Dalecarlia Plant to possibly eight, and the estimated increase at the McMillan Plant is from one or two shipments to six or seven shipments per week.

Although additional truck traffic will be one outcome of your anticipated change in operations, it will no longer be necessary to ship and store compressed chlorine gas, which is potentially lethal in the event of a spill. This will greatly reduce the risk to motorists and the surrounding community. As with all forms of increased commercial shipping in the Washington metropolitan area, we continue to consider and recommend that shipping and receiving occur in off-peak hours and at night whenever feasible.

It is understood that all shipments to and from your plants are handled by responsible, permitted HAZMAT carriers, and that all associated regulations are being observed. The Motor Carrier Division in SHA's Office of Traffic and Safety is readily available to provide additional information regarding the safe shipping and handling of hazardous materials.

Thank you, again, for your letter. If you have any further questions or comments, please do not hesitate to contact Mr. Tom Hicks, Director of Traffic and Safety, SHA at 410-787-5815, toll-free 888-963-0307 or via email at thicks@sha.state.md.us. SHA will be pleased to assist you.

Sincerely,

Neil J Pedersen

Neil J. Pedersen
Administrator

cc: Tom Hicks, P.E., Director of Traffic and Safety, SHA
Mr. Darrell B. Mobley, District Engineer, SHA

TAB D

CONCERNED NEIGHBORS
Bethesda, MD
Washington, DC

Mr. Thomas P. Jacobus
General Manager
Washington Aqueduct
U.S. Army Corps of Engineers, Baltimore District
5900 MacArthur Boulevard, N.W.
Washington, D.C. 20016-2514

Re: Proposed System Improvements of the Dalecarlia WTP and the McMillan WTP for Disinfection and pH Control

Dear Mr. Jacobus:

We have reviewed the Public Notice for the Improvements for Disinfection and pH Control at the Dalecarlia Water Treatment Plant and the McMillan Water Treatment Plant. We request that an Environmental Impact Assessment ("EIS"), not an Environmental Assessment, be conducted on these proposals. Further, we request that the projects be separated into two Environmental Impact Assessments with one covering the Disinfection improvements and the second covering the pH Control.

According to the CEQ, the National Environmental Policy Act states that an EIS is to be initiated when:

"Implementation of the proposed action or plan may directly cause or induce changes that significantly:

(1) Displace population;

(2) Alter the character of existing residential areas;

(3) Adversely affect a floodplain; or

(4) Adversely affect significant amounts of important farmlands as defined in requirements in §6.302(c), or agricultural operations on this land.

(f) The proposed action may, directly, indirectly or cumulatively have significant adverse effect on parklands, preserves, other public lands or areas of recognized scenic, recreational, archaeological, or historic value; or

(g) The Federal action may directly or through induced development have a significant adverse effect upon local ambient air quality, local ambient noise levels, surface water or groundwater quality or quantity, water supply, fish, shellfish, wildlife, and their natural habitats."

[50 FR 26315, June 25, 1985, as amended at 51 FR 32611, Sept. 12, 1986]

We believe that a project that considers the expansion or building of facilities at the Dalecarlia Water Treatment Plant requires an EIS because it may alter the character of existing residential areas, adversely affect a floodplain, have significant adverse effect on parklands and other public lands in the form of the National Capital Crescent Trail, and have a significant adverse effect upon local ambient air quality and local ambient noise levels.

As we have requested with past Environmental Impact Assessments, we would like residents to have the opportunity to participate fully in the NEPA process starting with an opportunity to participate in the development of the screening criteria for these two projects.

We would like the following neighborhood concerns to be addressed in an EIS:

- What are the safety risks to residents from the delivery, storing, usage, or cleaning of Aqueous Hypochlorite and Caustic Soda?
- What are the plans for using or disposing of excess bulk liquid chlorine?
- What impact will the additional trucks have on ambient noise levels as they travel neighborhood roads and within the MacMillan and Dalecarlia facilities? What routes will the trucks travel? What hours will the truck travel: During rush hour? During school bus hours? Will trucks incorporate alternate clean burning fuels? Will truck sizes be limited for the residential roads?
- Will trees be cleared to build or expand the facilities? What air quality and noise impacts will the new or expanded facilities have on neighbors and the National Capital Crescent Trail?

We look forward to your prompt response.

Sincerely,

Debra Graham Elizabeth Adams Gary Klein

TAB E

CHRIS VAN HOLLEN
8TH DISTRICT, MARYLAND

COMMITTEE ON
EDUCATION AND THE WORKFORCE

COMMITTEE ON GOVERNMENT REFORM

COMMITTEE ON THE JUDICIARY

Congress of the United States
House of Representatives
Washington, DC 20515

1419 LONGWORTH HOUSE OFFICE BUILDING
WASHINGTON, DC 20515
(202) 225-5341

DISTRICT OFFICES:
51 MONROE STREET, #507
ROCKVILLE, MD 20850
(301) 424-3501

3409 RHODE ISLAND AVENUE
MOUNT RAINIER, MD 20712
(301) 927-5223

www.house.gov/vanhollen

July 17, 2006

Mr. Thomas P. Jacobus
General Manager
Washington Aqueduct
U.S. Army Corps of Engineers
5900 MacArthur Boulevard, NW
Washington, DC 20016-2514

Dear Mr. Jacobus:

I am writing to request that an Environmental Impact Statement be conducted on the proposals for the system modifications at the Dalecarlia Water Treatment Plant relating to disinfection and control of pH.

These changes, which contemplate the expansion or building of facilities, require an EIS under the National Environmental Policy Act for several reasons, including their impact on the character of neighboring residential areas, adverse effect on a floodplain, significant adverse effect on parklands and other public lands of recognized scenic and recreational value, and significant adverse effect on local ambient air quality and noise levels.

I concur with the views expressed in the letter dated July 17, 2006 from Concerned Neighbors and signed by Debra Graham, Elizabeth Adams and Gary Klein, and respectfully request that the concerns raised in their letter be addressed in an EIS. A copy of that letter is attached for your convenience.

Thank you for your attention to this important matter.

Sincerely,

Chris Van Hollen
Member of Congress

Appendix B. Feasibility Study EE&T (2007)

FEASIBILITY STUDY
SODIUM HYPOCHLORITE AND CAUSTIC SODA FACILITIES

Prepared for

U.S. Army Corps of Engineers
Washington Aqueduct Division
Washington, DC

Prepared by

Environmental Engineering & Technology, Inc.
712 Gum Rock Court
Newport News, VA 23606
(757) 873-1534

COMMONWEALTH OF VIRGINIA
DAVID A. CORNWELL
No. 013083
3/30/07
PROFESSIONAL ENGINEER

March 2007

CONTENTS

TABLES

FIGURES

DRAWINGS

CHAPTER 1
SCOPE OF WORK AND BASIS OF REPORT

The Washington Aqueduct, a United States Army Corps of Engineers organization, maintains and operates the Dalecarlia and McMillan Water Treatment Plants, which together serve potable water reliably to approximately one million people in the District of Columbia and northern Virginia.

Currently, both Dalecarlia and McMillan use chlorine gas for primary disinfection and lime for pH control. The Washington Aqueduct has previously commissioned feasibility studies to explore switching from chlorine gas to sodium hypochlorite for disinfection[1] and to add caustic soda feed capabilities for final pH control[2]. EE&T has been directed by the Washington Aqueduct to review and update these previous studies and to provide a comprehensive feasibility study for sodium hypochlorite and caustic soda facilities at both the Dalecarlia and McMillan treatment plants. The scope of this feasibility study generally directed EE&T to evaluate, locate, and size storage facilities for:

- Sodium hypochlorite
- Caustic soda
- Sulfuric acid

Over the course of the study, it became apparent that the relationships between the proposed process changes and their effects on the finished water pH were more complex than was initially thought. This led the Washington Aqueduct to issue a modification to the original scope of services to include a supplementary evaluation to more fully characterize potential requirements for caustic soda and acid. This supplementary evaluation focused on using pH measurements taken at the plants along with bench-scale testing to explore the accuracy of the pH model[3] used to determine the lime, caustic soda, and sulfuric acid requirements for both Dalecarlia and McMillan. In essence, the result this supplementary evaluation was a sensitivity analysis for the RTW model, which illustrated the circumstances where the model correctly

[1] Sodium Hypochlorite Feasibility Study by AH Environmental Consultants, Inc. (2001)
[2] pH Study Report by CH2M Hill (2004)
[3] The Rothberg, Tamburini & Winsor (RTW) Model for Water Process and Corrosion Chemistry, Version 4.0

predicted pH changes observed in the field and in the lab and the circumstances where the model varied from observations. This allowed for a more accurate estimation of storage requirements for the pH control chemicals. Additionally, the modification to the scope of services included a water utility literature search and interview-type surveys of other water utilities that utilize similar treatment processes to those proposed by the Washington Aqueduct. The literature review and summaries of the interviews conducted are included in their entirety in Appendix A.

This report addresses the tasks set forth in the both the original and modified scope of services, and provides a comprehensive feasibility study for the proposed sodium hypochlorite, caustic soda, and sulfuric acid facilities at both Dalecarlia and McMillan. The specifics of the report are discussed below.

Chapter 2 outlines the requirements for sodium hypochlorite facilities. There were three alternatives considered for implementing sodium hypochlorite disinfection in accordance with the AH Environmental Consultants report. These are:

1. Purchasing a 12 percent solution of sodium hypochlorite to be stored in a climate-controlled environment
2. Purchasing a 12 percent solution of sodium hypochlorite to be diluted to and stored at a concentration of approximately 6 percent
3. Generating sodium hypochlorite on-site by passing a brine solution through an electric field. This produces a dilute solution of approximately 0.8 percent sodium hypochlorite

The advantages and disadvantages of each of these three alternatives are discussed in detail in Chapter 2. This discussion is followed by analysis of storage options, feed point locations, and the impact switching to sodium hypochlorite will have on the number of truck deliveries required at both plants.

Chapter 3 discusses the pH control chemicals, combining the analysis of the need for caustic soda and sulfuric acid storage facilities. The chapter begins with discussion of the pH testing performed under the modification to the scope of services, along with a description of the pH modeling that was performed. This is followed by a summary of pH control chemical storage requirements determined by the modeling work. Two operating schemes for upward pH adjustment are considered: using caustic soda to trim the final pH after lime has been used to make bulk adjustments and using only caustic soda to make upward pH adjustment. The possibility that the final pH may be above the pH target and require downward adjustment with sulfuric acid was considered for both options. Also, the impact of changing from alum coagulation to polyaluminum chloride (PACl) coagulation was considered for both options. An analysis of storage options, feed point locations, and truck delivery requirements for the pH control chemicals follows the discussion of the storage requirements.

The impact of switching to PACl coagulation is discussed in Chapter 4. This chapter begins with discussion of the relationship between the optimal dose of PACl to the optimal dose of alum. This is followed by an analysis of the effect of coagulation pH on disinfection byproduct removal. The impact of switching from alum to PACl on caustic soda and sulfuric acid use is also discussed. Finally, the suitability of using the existing alum storage tanks, pumps, and discharge lines with PACl is evaluated.

Finally, Chapter 5 provides an alternatives analysis for the issues discussed in the preceding chapters. Budget cost estimates are provide for the hypochlorite alternatives described in Chapter 2 and recommendations are made for two scenarios: one recommendation applies if the Washington Aqueduct decides to use delivered bulk sodium hypochlorite and one recommendation is valid if the Washington Aqueduct decides to generate sodium hypochlorite on-site. The recommended pH control strategy for caustic soda and sulfuric acid is provided for both Dalecarlia and McMillan, along with budgetary cost estimates. Finally, an assessment on PACl storage and feeding is provided.

In addition to this report, supporting documentation for the National Environmental Policy Act (NEPA) process has been prepared and submitted to the Washington Aqueduct.

CHAPTER 2
CHLORINE ALTERNATIVES ANALYSIS

HYPOCHLORITE OVERVIEW

Both McMillan Water Treatment Plant (WTP) and Dalecarlia WTP utilize chlorine gas for disinfection. As directed in the scope of services, the Washington Aqueduct desires to switch disinfectants from chlorine gas to hypochlorite. The use of sodium hypochlorite enables some advantages over chlorine gas. Sodium hypochlorite is less hazardous to store, handle, and use than chlorine gas. Sodium hypochlorite also eliminates the risk of poisonous gas danger to the area in the event of a chlorine leak. This in turn reduces the need for creating a Risk Management Plan (RMP) and eliminates the need for scrubber facilities.

With the switch to hypochlorite, a number of issues must be considered. Unlike chlorine gas, sodium hypochlorite degrades over time. The rate of degradation depends on the concentration of the hypochlorite solution and the temperature at which it is stored. These issues will affect the requirements for the hypochlorite storage facilities. Similarly, different facilities are required depending on whether the hypochlorite is delivered as a bulk solution or whether it is generated on-site.

The following sections will discuss the pros and cons of delivered and stored 12 percent hypochlorite, delivered 12 percent and stored 6 percent hypochlorite, and on-site generation of hypochlorite. This will be followed by discussion of storage, delivery and handling requirements for the three hypochlorite options.

Hypochlorite Issues

Sodium hypochlorite is commercially available with chlorine concentrations of 12 to 15 percent. The chemical itself is rather unstable and will lose free available chlorine (FAC) over time. There are many factors that affect the stability of the solution including strength, retention time, temperature, pH of solution, sunlight, and contact with impurities.

There are several common ways of expressing the concentration of sodium hypochlorite solutions including: grams per liter available chlorine, trade percent available chlorine, weight percent available chlorine, and weight percent sodium hypochlorite. Trade percent available chlorine refers to the mass of available chlorine, in grams, contained in 100 mL of sodium hypochlorite solution. Unless otherwise specified, concentrations of sodium hypochlorite solutions used in this report will be expressed as trade percent available chlorine.

Sodium hypochlorite is most commonly shipped at 12 percent. This concentration of hypochlorite is equivalent to 1 lb of free available chlorine per gallon of solution.[4] Because sodium hypochlorite is most stable with a solution pH between 11.9 and 13.0, manufacturers typically maintain an excess of sodium hydroxide in the hypochlorite solution to prevent decomposition. For 12 percent sodium hypochlorite, a range of approximately 0.35 to 4.00 grams per liter of excess sodium hydroxide will maintain the solution pH in the desired range.

Advantages and Disadvantages of Storing 12 Percent Sodium Hypochlorite

There are two primary benefits of storing sodium hypochlorite at the strength of 12 percent when compared to more dilute solutions. The first benefit is that, by storing the sodium hypochlorite at a more concentrated strength, smaller storage volumes are needed to store the required amount of disinfectant. This reduces the capital costs for initial construction, in addition to reducing the amount of equipment that must be maintained. Storage requirements based on hypochlorite strength will be discussed in further detail later in this chapter. The other benefit to storing sodium hypochlorite at 12 percent is that this is the concentration at which the hypochlorite is shipped. Basically, when stored at this strength, the sodium hypochlorite is unloaded directly from the truck into the storage tanks. If a more dilute concentration of sodium hypochlorite is stored, a dilution procedure must be followed every time a truck is unloaded. Dilution options will be explained in depth when the storage of 6 percent sodium hypochlorite is discussed later in this chapter.

[4] Per AWWA B300-04

Table 2.1

Sodium hypochlorite degradation at 25°C

Holding time (days)	12 percent		6 percent	
	Available chlorine (g/L)	Percent of original concentration (percent)	Available chlorine (g/L)	Percent of original concentration (percent)
0	120.0	100	60.0	100
7	116.1	97	59.4	99
14	112.5	94	58.9	98
21	109.1	91	58.4	97
28	105.9	88	57.8	96

The primary disadvantage to storing sodium hypochlorite at 12 percent available chlorine is solution degradation. Degradation is a significant issue when storing sodium hypochlorite at higher concentrations because hypochlorite decomposition increases with solution strength. To illustrate this, Table 2.1 shows the concentrations of two sodium hypochlorite solutions stored for 28 days at 25°C.

There are two pathways for sodium hypochlorite decomposition. One pathway, shown below, leads to the formation of oxygen.

$$OCl^- + OCl^- \rightarrow O_2 + 2Cl^- \tag{2.1}$$

However, this decomposition pathway is a very slow side reaction, barring the presence of transition metal ions such as iron, nickel, copper, and cobalt. Therefore, under normal conditions, the second decomposition pathway dominates. This pathway leads to the formation of chlorate and chloride ion, and is shown below.

$$3OCl^- \rightarrow ClO_3^- + 2Cl^- \tag{2.2}$$

As the decomposition of sodium hypochlorite is increased at higher concentration, so too is chlorate formation increased. While the United States Environmental Protection Agency (EPA) has not set a maximum contaminant level (MCL) for chlorate, a risk assessment conducted by the Office of Pesticides has found that exposure to inorganic chlorates in drinking water is a concern. Therefore, measures should be taken to lower decomposition of the hypochlorite solution, both to maintain solution strength and to decrease chlorate formation.

One method to accomplish this goal is to control the temperature of the sodium hypochlorite solution. Degradation of sodium hypochlorite is highly temperature dependant; studies have shown that, for solutions in the range of 5 to 16 percent by weight of sodium hypochlorite, the decomposition rate factor increases approximately three to four times for every 10°C rise in temperature. Figures 2.1 through 2.4 show the effect of temperature on both sodium hypochlorite decomposition and chlorate formation. These figures were generated using the predictive model developed by Gordon et al.[5]

.

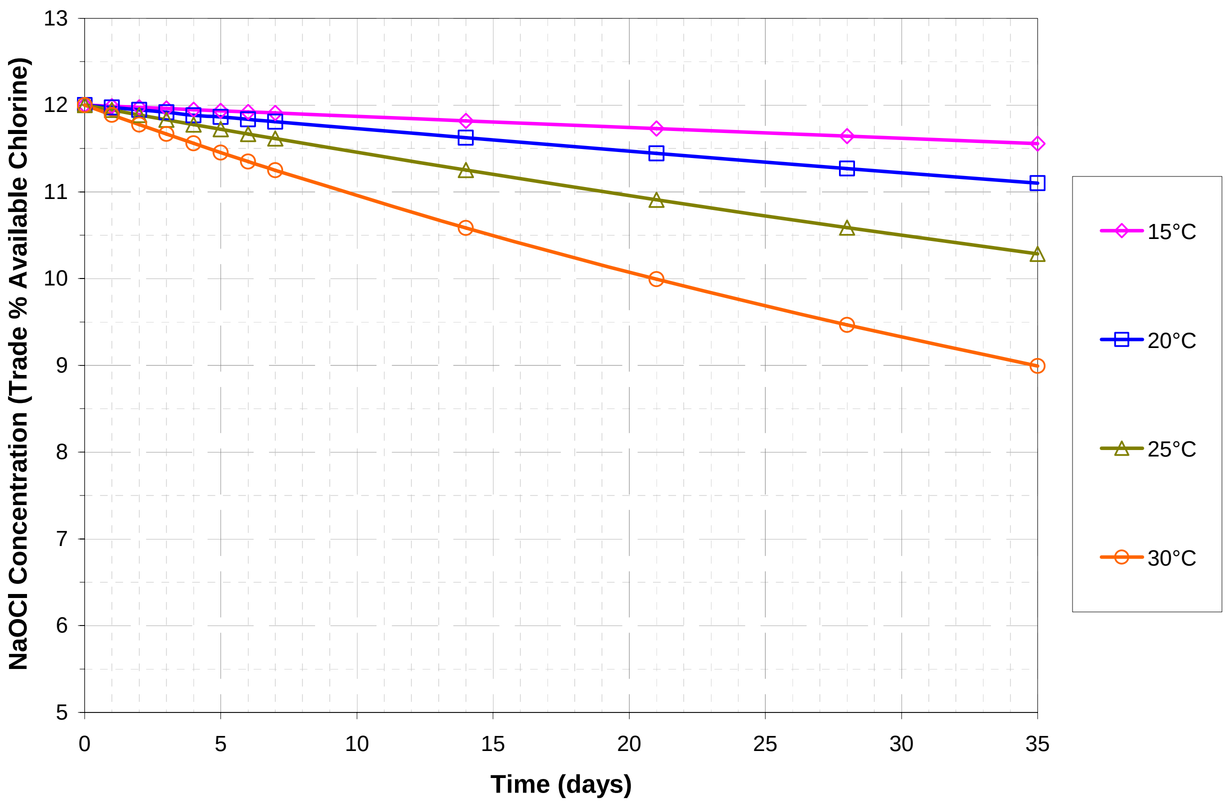


Figure 2.1 Degradation of 12 percent sodium hypochlorite solution over time

[5](Gordon G., L. Adam, and B. Bubnis. 1995. *Minimizing Chlorate Ion Formation in Drinking Water When Hypochlorite is the Chlorinating Agent*. AwwaRF: Denver, CO).

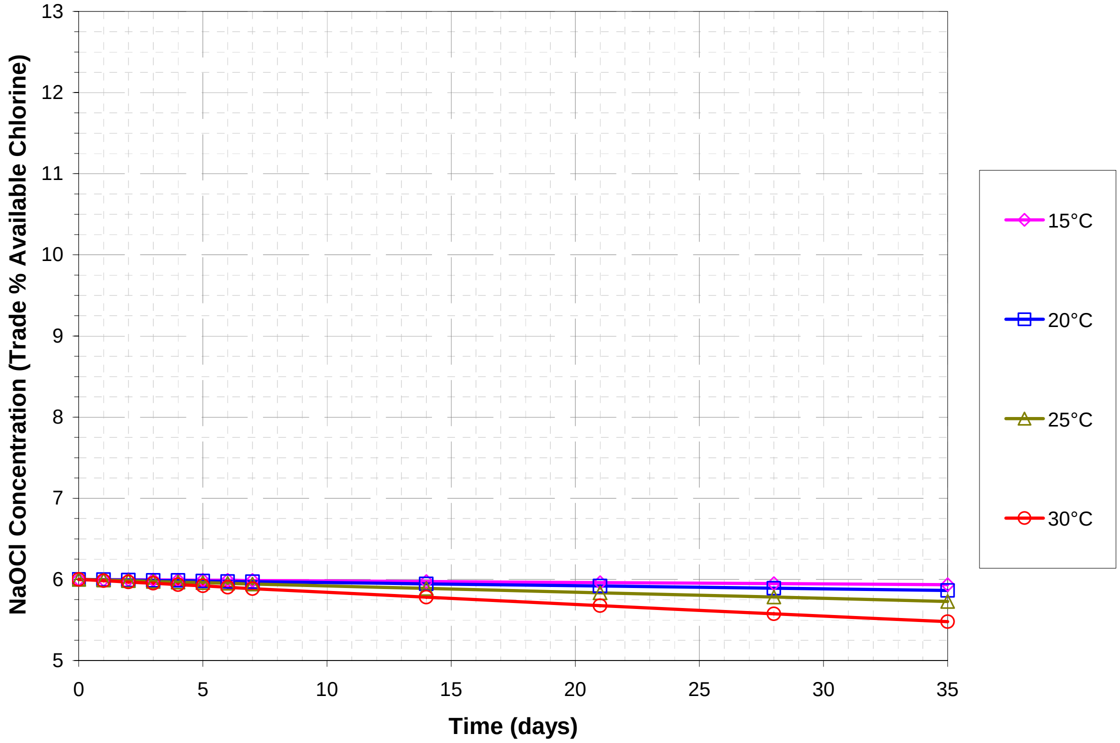


Figure 2.2 Degradation of 6 percent sodium hypochlorite solution over time

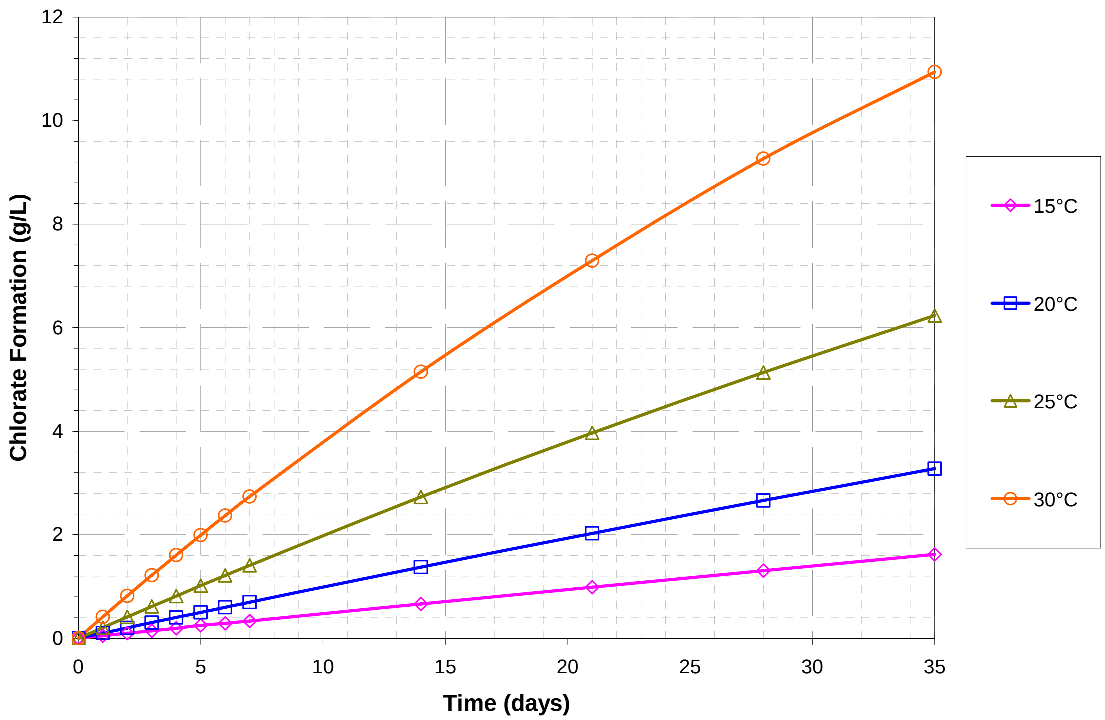


Figure 2.3 Chlorate formation resulting from the storage of 12 percent sodium hypochlorite solution

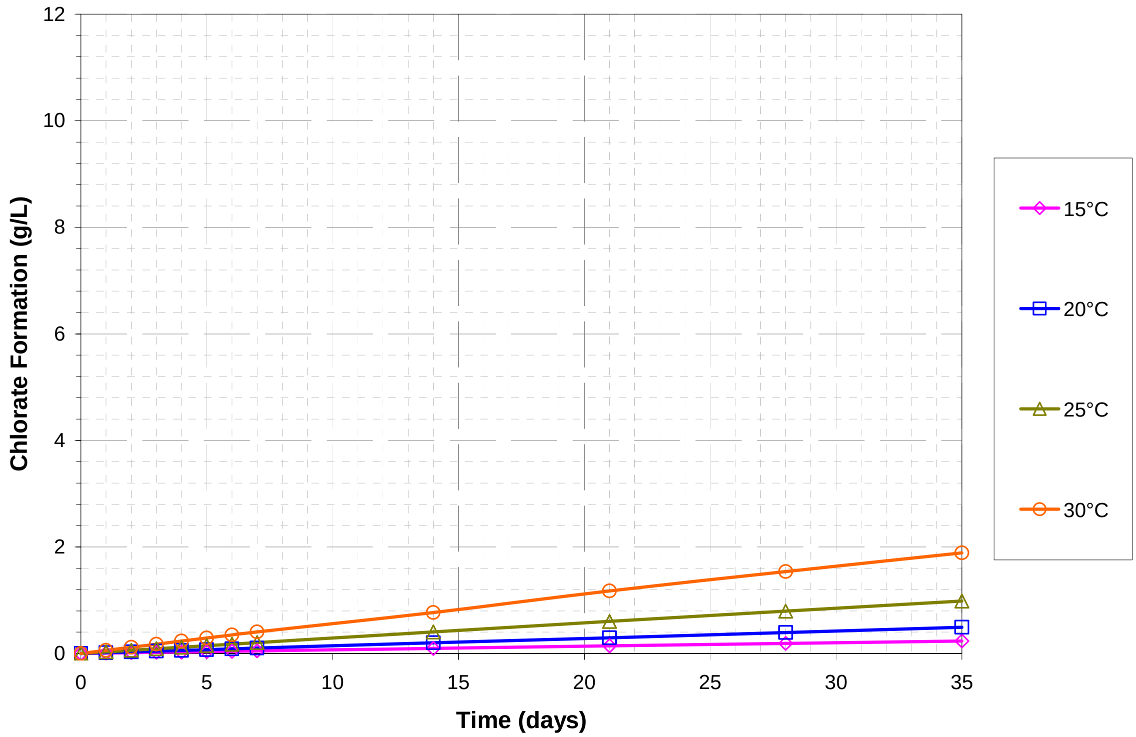


Figure 2.4 Chlorate formation resulting from the storage of 6 percent sodium hypochlorite solution

Clearly, storage temperature has a significant impact on sodium hypochlorite degradation and chlorate formation. For example, a 12 percent sodium hypochlorite solution stored at 20°C will lose less than 6 percent of its available chlorine after 28 days. In this same period of time 2.6 g/L of chlorate will form. With a chlorine dose of 6.4 mg/L for disinfection (equal to the median chlorine dose between January 2004 to April 2006), this will result in an increase of 0.14 mg/L chlorate in the finished water. Conversely, repeating this analysis for a 12 percent sodium hypochlorite solution stored for 28 days at 25°C, we find that decomposition of the sodium hypochlorite would add 0.31 mg/L of chlorate to the finished water at a chlorine dose of 6.4 mg/L. Thus, a small increase in storage temperature can significantly increase chlorate levels in the finished water.

While both solution degradation and chlorate formation will always be lower for the more dilute solution, by maintaining a solution temperature of 20°C or less, solution degradation and chlorate formation can be minimized for the more concentrated sodium hypochlorite solution as well. Chlorate formation and hypochlorite decomposition can be further reduced by rotating the sodium hypochlorite stocks to reduce the storage retention time.

Finally, another concern with storing hypochlorite at 12 percent is increased off-gassing associated with hypochlorite degradation. Because off-gassing is associated with hypochlorite degradation, it is more of a concern at 12 percent than at more dilute concentrations. If the hypochlorite storage and delivery system is not designed to accommodate off-gassing, off-gassing can cause problems throughout the system including vapor-lock of pumps and leaks due to pipe or valve expansion. However, because off-gassing may also occur with dilute solutions of sodium hypochlorite, properly designed systems should accommodate potential off-gassing regardless of the strength of the stored solution.

Sodium hypochlorite will also add sodium to the water where as chlorine gas does not. Based on equal molar addition of sodium and chlorine, about 0.65 mg/L of sodium will be added per mg/L of chlorine added. This amount of sodium unto itself is well below dietary recommendations for individuals on a low sodium diet.

Advantages and Disadvantages of Storing 6 Percent Sodium Hypochlorite

The primary advantage of storing sodium hypochlorite diluted to 6 percent is the reduction in degradation of the hypochlorite. As the previous section demonstrated, significantly less hypochlorite decomposition occurs when the solution is diluted, even at higher temperatures. Therefore, unlike 12 percent sodium hypochlorite, it is not imperative to maintain a solution temperature of 20°C or lower when stored at 6 percent. Also, for a given set of conditions (storage temperature, holding time, etc.) 6 percent hypochlorite solution will lose less of its strength and form less chlorate than 12 percent sodium hypochlorite.

However, there are significant disadvantages to storing diluted sodium hypochlorite. Because of the lower chlorine concentration, the storage volume required to store a given amount of chlorine as 6 percent sodium hypochlorite is twice that required if the hypochlorite is stored at 12 percent. In addition to the increased capital costs associated with doubling the size of the storage facility, the additional tanks and equipment will increase maintenance requirements, which in turn increase operational costs.

Furthermore, it is too costly to ship sodium hypochlorite at 6 percent, so it must be diluted from 12 to 6 percent on-site. This dilution process significantly increases the complexity of storing hypochlorite.

There are numerous options for design of the dilution system. Sodium hypochlorite can be diluted in batches by adding a calculated amount of water to the known amount of 12 percent sodium hypochlorite, or automatic dilution systems may be used to simplify the process. In either case, it is recommended that an additional storage tank (or two in the case of the volume required at Dalecarlia) be used to receive the 12 percent hypochlorite solution from the delivery trucks. This tank can be used for the dilution process if batch dilution is used, or can serve as the feed for an automatic dilution system.

Also, potable water at the Washington Aqueduct plants used for diluting the hypochlorite solution must be softened prior to dilution to avoid precipitation of calcium carbonate in the storage vessels. This softening is typically accomplished with ion-exchange resins, which must periodically be regenerated. Depending on the type ion-exchange resin used, the regenerant needed for this process will be a concentrated acid, base, or brine solution, probably salt brine in this case. The regeneration process will also produce waste brine that must be disposed.

Finally, because manufacturers maintain the pH of sodium hypochlorite solutions by adding excess caustic soda, the pH of the diluted hypochlorite solution must be considered. If the dilution process lowers the concentration of the excess caustic soda to less than approximately 0.35 grams per liter, the pH of the solution may fall below 11.9 at which point the sodium hydroxide will rapidly decompose. Though the amount of excess caustic soda in the solution is typically large enough that this will not occur, if it does happen it will be necessary to add caustic soda during the dilution process. While the dilution of sodium hypochlorite with softened water is not an exothermic reaction by itself, the addition of caustic soda will cause significant amounts of heat to be released. This is an additional factor that must be considered in the design and operation of a hypochlorite dilution facility. Purchase specifications should be carefully written to avoid the need to add caustic to the diluted sodium hypochlorite.

Of course, while the discussion above focuses on two concentrations, sodium hypochlorite can be stored at any concentration to which the solution can be diluted. It is difficult to obtain commercially manufactured sodium hypochlorite at concentrations greater than 12 percent due to the high rate of degradation at higher concentrations. Likewise, because solution degradation and chlorate formation rates are minimal at 6 percent, most utilities find the cost of diluting sodium hypochlorite below this concentration to outweigh any benefits gained by the lower solution strength. Any plan to store sodium hypochlorite between 6 and 12 percent should consider the costs of the necessary dilution equipment and increased storage volume as well as the benefit of decreased hypochlorite degradation and chlorate formation.

It may also be possible to vary the strength of sodium hypochlorite that is stored (e.g. store 12 percent solution during the one season and 6 percent solution during the rest of the year). However, it may be difficult to implement such a plan to the Washington Aqueduct's benefit. Presumably, the Washington Aqueduct could attempt to reduce the required sodium hypochlorite storage by storing more concentrated solution during periods of high chlorine demand and storing less concentrated solution during periods of low chlorine demand. Alternatively, the Washington Aqueduct could try to reduce solution degradation and chlorate formation by storing less concentrated sodium hypochlorite during periods of warm weather, while increasing the concentration of the hypochlorite during periods of cooler weather. The problem with both scenarios is that water demand, and thus chlorine demand, is highest during the summer, when the weather is the warmest. Therefore, if the Washington Aqueduct sizes the storage facilities to store only 12 percent sodium hypochlorite during peak demand, there is little practical benefit to diluting during the winter, when the lower temperatures will naturally decrease the rate of chlorate formation and solution degradation. On the other hand, if the Washington Aqueduct dilutes to 6 percent during periods of warm weather, there is little practical benefit to increasing the sodium hypochlorite degradation during cooler periods because less disinfectant is needed during those times. For these reasons, this feasibility study has focused on sizing storage facilities for either 6 percent or 12 percent, and has not considered varying the concentration of sodium hypochlorite during different times of the year.

On-Site Hypochlorite Generation

In addition to having bulk sodium hypochlorite solution delivered to the treatment plants, on-site generation of sodium hypochlorite is a feasible option. On-site generation of sodium hypochlorite requires salt, water, and electricity. The amounts usually associated with producing 1 lb of free available chlorine (FAC) are in the range of 2.5 to 3.5 lb of NaCl, 15 gallons of water, and 2.0 to 2.7 kWh (AC) of electrical power for the electrolytic cell (460 to 480 VAC, 3 phase).

The salt is delivered in 25-ton (50,000-lb) trucks or by train. Sodium chloride (NaCl) can safely be stored in the same building as the generated 0.8 percent sodium hypochlorite solution. The bottom of the salt storage tanks allows water to mix with the salt to form a 30 percent saturated brine solution. Prior to being fed to the hypochlorite generator, the brine is softened and temperature-controlled between 50 and 75^{o}F. The brine solution is diluted again to a 3 percent or less solution to further minimize scaling of electrodes, and thus extends the intervals of acid cleaning from a few weeks to several months. On-site hypochlorite generators are modular and several units can be connected in parallel to supply the needed amount of FAC.

The solution is sent from the generator(s) to a 1- to 2-day supply tank where the effluent flow is controlled by metering pumps. The level in the day tank is monitored and kept full by allowing constant fill or momentary fill by one, some, or all of the generators in place.

A significant difference between sodium hypochlorite generated on-site and the delivered bulk sodium hypochlorite is that solution generated on-site is much less concentrated than commercially manufactured sodium hypochlorite. Conventional on-site sodium hypochlorite generators produce hypochlorite at a concentration of around 0.8 percent. While this requires that a much higher volume of hypochlorite solution be used to achieve a given chlorine dose, it has the benefit of being a much less hazardous material than more concentrated hypochlorite solutions.

On-site generated sodium hypochlorite will also add sodium to the finished water at approximately the same level as trucked in sodium hypochlorite.

Operationally, on-site generation of sodium hypochlorite is not a complex process. Most on-site generation systems are fully automated, so the labor requirements to operate the systems are minimal. Typically, operators will only need to periodically check the system to ensure it is operating properly, and perform periodic cleaning and maintenance. However, it should be recognized that the generation of chemicals is a process not typically encountered at water treatment plants, and the majority of operators may not be familiar with this process. Therefore, if the Washington Aqueduct chooses to implement on-site sodium hypochlorite generation, it will be necessary to provide training to the existing water treatment plant operators to familiarize them with the process.

Non-Conventional On-Site Hypochlorite Generation Systems

In addition to conventional on-site sodium hypochlorite generation system, EE&T looked at the feasibility of newer on-site hypochlorite generation technologies. One of the technologies considered was the Klorigen® process. Unlike conventional on-site hypochlorite technologies, the Klorigen® process also produces caustic at 15 percent concentration, which can be used for pH adjustment and thus reduces the dependence on chemical suppliers. The system can also be configured to produce sodium hypochlorite only. The generated sodium hypochlorite is at trade strength (12 percent) and thus 15 times more concentrated than NaOCl produced from conventional onsite generators (0.8 percent), which reduces the footprint needed for chemical storage. Also, each lb of Klorigen®-produced Cl_2 uses 20 percent less power, half the salt, and 15 times less water than conventional on-site generators.

However, Klorigen® is a complex automated system which may not appear user-friendly to operators experienced with handling chlorine cylinders. The working environment can be hazardous (handling of caustic soda, hydrochloric acid, etc.). Currently, repairing or replacing a part (e.g., a feed pump) requires the entire shutdown of the unit. Starting up the unit can require up to a day for temperature and voltage to reach the set points. The Nafion® membrane in the cells is fragile and susceptible to damage when voltage differential across it is greater than 5 V (replacing the membrane is expensive and can take up to several weeks).

Proper startup sequence is required (e.g., feeding the caustic side before the brine side in the cells, otherwise the osmotic pressure differential damages the Nafion® membrane by pushing it away from the support metal plate). Because safety is the guiding principle of the system design, if a part is not functioning within the set parameters, the entire unit shuts down (and thus a day is required start up the unit again). The system employs many sensors (level, pH, etc.), flow switches, etc. that need to be checked regularly (e.g., mineral scale on the sensors) otherwise false alarms may trigger an unnecessary unit shutdown.

Because of the operational complexity of the Klorigen® system, there would be a steep learning curve for operators to become familiar with the process. For this reason, further consideration has not been given to the Klorigen® system.

Advantages and Disadvantages of On-Site Sodium Hypochlorite Generation

The on-site systems have grown in popularity primarily on the west coast but are becoming increasingly popular on the east coast. Although few systems are currently in place at plants as large as Dalecarlia or McMillan, nonetheless some large utilities are now making the transition from delivered hypochlorite to on-site generation (e.g., Baltimore).

One of the primary benefits of on-site generation is that it uses inexpensive raw materials (i.e., water and salt). However, on-site generation also requires 2.0 to 2.7 kWh to produce the equivalent of 1 lb Cl_2. Thus, fluctuating energy prices would substantially impact the operations and maintenance (O&M) costs associated with on-site facilities. Relying on off-peak hours and performing proper maintenance can optimize the power consumption. Also, while changes in power costs are most directly experienced by the Washington Aqueduct with on-site generation, presumably these changes will also impact commercial sodium hypochlorite manufacturers, who will in turn pass along increased costs in the price of their product. Therefore, it is reasonable to assume that the Washington Aqueduct will be affected by increases in power prices regardless if the sodium hypochlorite is purchased in bulk or generated on-site.

The price of sodium hypochlorite has risen over the past two years and does not show signs of slowing down. The cost today for delivered 12 percent sodium hypochlorite is about \$0.78 per lb Cl_2. The on-site generators differ very little on the amount of material consumption between manufacturers. Salt usage varies from 2.5 to 3.0 lb per lb of chlorine, and power at 2.0 to 2.7 kWh per lb of chlorine. With Dalecarlia and McMillan paying an average of \$0.075 per kWh and the average price of salt at \$0.04 per pound, the equivalent price per pound of chlorine ranges from \$0.30 and \$0.34 per pound Cl_2 (includes \$0.03 per pound Cl_2 for maintenance), which corresponds to a 56 to 61 percent reduction in O&M compared to delivered 12 percent sodium hypochlorite. Later in this chapter the capital costs for on-site generation and delivered bulk sodium hypochlorite will be discussed and compared.

Safety is another significant benefit for the on-site process compared to 12 percent hypochlorite, because a 0.8 percent solution produced by the generators is considered non-hazardous and thus relieves plants of OSHA process safety management training and risk management planning. On-site generation would not only decrease the number of deliveries but also eliminate transportation of hazardous material chemicals like 12 percent sodium hypochlorite.

Another benefit to on-site hypochlorite generation is that, while both 12 percent hypochlorite and salt (NaCl) can be trucked in relatively quickly and easily, salt deliveries would be far fewer than bulk-hypochlorite deliveries. This will be discussed at greater depth later in this chapter.

Finally the concern of degradation and chlorate formation can be avoided because on-site generated NaOCl is actually produced and stored on a daily basis (i.e., not 30-day-long storage) so that degradation or chlorate formation becomes a moot issue.

One downside to on-site hypochlorite generation is that parts are generally not interchangeable between manufacturers. While there are on-site generation systems by different manufacturers on the market, once a particular system has been selected by the Washington Aqueduct, that manufacturer will be the sole-source for replacement parts. This could potentially increase costs for the Washington Aqueduct in the future, as it would no longer be possible to competitively bid for parts.

Another potential disadvantage to on-site generation is that, because the sodium hypochlorite is generated at a low concentration, it is not economical to store more than 1 to 2 days worth of disinfectant. While this is not an issue when the system is operating properly, the inability to store several days worth of disinfectant makes the reliability of the on-site hypochlorite generator a critical factor. If multiple hypochlorite generators or storage tanks fail or are taken out of service, it may reduce the amount of disinfectant that the Washington Aqueduct is capable of administering, which in turn could limit the amount of water that could be produced. Additionally, because the on-site generation of sodium hypochlorite requires large amounts of electrical power, local power failures could potentially impact sodium hypochlorite production.

There are measures the Washington Aqueduct can take during the design phase to mitigate these issues. For example, it is possible to ensure that system can operate if a generator or tank fails or is taken out of service by including redundant hypochlorite generators and by dividing the sodium hypochlorite storage among several tanks. To reduce the impact of power failures it will be necessary to provide significant emergency power generation capacity to maintain operation of the system during power outages. Finally, it may be possible to ensure a consistent supply of sodium hypochlorite by supplementing the on-site generation facilities with connection piping and backup feed systems that would allow temporary bulk sodium hypochlorite storage tanks to be used. This would allow the Washington Aqueduct to use purchased bulk sodium hypochlorite in the event that the on-site generators are unable to operate.

STORAGE AND DELIVERY ISSUES

Bulk Hypochlorite Storage and Layout

In order to size alternative storage facilities for liquid hypochlorite, it was necessary to determine the amount of disinfectant the Washington Aqueduct desired at each facility. The Washington Aqueduct provided the following values for storage calculations:

Dalecarlia	-	150 tons FAC
McMillan	-	70 tons FAC

This currently exceeds the existing chlorine storage supply goals of 90 tons Cl_2 and 48 tons Cl_2 for Dalecarlia and McMillan, respectively. The existing maximum possible storage at each plant is 126 tons Cl_2 for Dalecarlia and 102 tons Cl_2 at McMillan. Compared to the historical Cl_2 usage at each plant, the values the Washington Aqueduct provided for storage calculation would provide approximately 30 days storage at maximum flow and maximum dose or 45 days storage at design flow and average dose for both facilities.

AWWA Standard No. B-300 calls for liquid hypochlorite at a 12 percent solution to have 1 lb of free Cl_2 per gallon of liquid. Diluting the sodium hypochlorite to 6 percent reduces this to 0.5 lb of free Cl_2 per gallon of liquid Therefore the storage requirements are as follows:

Dalecarlia	-	300,000 gallons/month at 12 percent
		600,000 gallons/month at 6 percent
McMillan	-	140,000 gallons/month at 12 percent
		280,000 gallons/month at 6 percent

Using these storage volumes, EE&T determined feasible storage scenarios to store both 12 percent and 6 percent sodium hypochlorite at each facility.

McMillan WTP

Plan, site plan, and elevation view drawings are provided for four options for storing either 12 percent or 6 percent hypochlorite:

- Store 12 percent solution in the existing chlorine/chloramine building using four 35,000-gallon tanks (M1-SP, M1-P, M1-S)
- Store 6 percent solution in a new building using twenty 14,000-gallon tanks (M2-SP, M2-P, M2-S)
- Store 6 percent solution in a new building using eight 35,000-gallon tanks (M3-SP, M3-P, M3-S)
- Store 12 percent solution in a new building using ten 14,000-gallon tanks (M4-SP, M4-P, M4-S)

The first option is a logical tank size to store 12 percent solution in the existing building. This option requires the tanks to be built on-site and provides sufficient room for maintenance. As built in-place tanks are utilized, it would be necessary to tear down the tanks in-place and remove them in sections for future replacement. Likewise, there is sufficient room to bring in sections to rebuild replacement tanks in-place.

This option can be compared to the fourth option (Drawing M-4) for storage of 12 percent hypochlorite using tanks that can be trucked in. This option would not fit in the existing building and still allow room for maintenance.

Options two and three are both for storing 6 percent hypochlorite with the trucked in versus built on-site tank options. With the build-on-site option there is clearly many different size tanks available. The 35,000-gallon tank size was selected to balance having too many tanks to maintain versus having too few if one is out of service. Note that for the trucked in tanks an allowed diameter of 12 feet was used. During the design phase it may be possible to allow a slightly larger tank diameter to be shipped via truck, but a more conservative approach was used for this analysis due to special permitting requirements for shipping tanks with diameters larger than 12 feet.

The logistical analysis of using the slow sand filters to store hypochlorite yielded the following:

- The new loads will be point loads not uniform loads and a structural engineer needs to evaluate the foundation
- The 1981 M&E drawings refer to the slow sand filter area as “Hazardous work area, filter section is in Poor Structural Condition”. Based on this previous engineer’s opinion, a structural engineer will need to evaluate the columns and roof structure integrity and determine repairs needed
- The current roof leaks and will need an assessment to determine repairs
- In order to install any reasonably sized tank, the sand will need to be removed and an opening needs to be constructed in front of each bay to allow the tanks to be slid in. Alternatively, shorter tanks could be used and enter through the existing opening and be turned to fit perpendicular between the columns
- Thirty-seven 6-ft diameter, 18-ft long horizontal tanks (manufacturer suggests 3:1 length to diameter ratio) would be required to store 12 percent hypochlorite and twice that for 6 percent solution
- Ventilation will be required which may result in some HVAC costs
- Manufacturers have expressed reluctance for on-site fabrication of larger tanks within the slow sand filters. Therefore 8-ft diameter tanks (factory-built) with a length that allows movement around the columns may likely be the only available option to install tanks in the slow sand filters

Dalecarlia WTP

For Dalecarlia four different options have been included for plan view, elevation view, and budgetary costs, as follows:

- 12 percent hypochlorite storage in a new building using trucked in tanks of 12-ft diameter (D1-SP, D1-P, D1-S)
- Same as above using built-on-site tanks of 25-ft diameter (D2-SP, D2-P, D2-S)
- 6 percent hypochlorite storage in a new building using trucked in tanks of 12-ft diameter (D3-SP, D3-P, D3-S)
- Same as above using built-on-site tanks of 25-ft diameter (D4-SP, D4-P, D4-S)

All four plans locate all of the sodium hypochlorite equipment in a new building to be constructed. Using the existing chlorine storage building to house a portion of the hypochlorite storage tanks under the 12 percent sodium hypochlorite scenario was considered, but it decided that it would be better to consolidate all of the hypochlorite storage in one building and instead use the existing chlorine storage building for caustic soda and sulfuric acid storage. The storage of these chemicals will be discussed in detail in Chapter 3.

ON-SITE GENERATION STORAGE AND LAYOUT

EE&T has provided drawings (M5-P, M5-S, D5-P, D5-S) of possible sodium hypochlorite on-site generation systems for each plant. While trying to keep the footprint as small as possible for Dalecarlia, adequate space was given to the equipment for operation, maintenance, and replacement. At McMillan the primary objective was to fit the system within the existing chloramine building.

Because of the unique characteristics of on-site generation, the production and storage requirements are calculated differently from those for bulk-ordered sodium hypochlorite. The on-site generators must have the capability to produce the maximum daily usage. The sizing of the facilities therefore shifts from a storage perspective (delivered sodium hypochlorite) to a production standpoint (on-site generation). Whereas storage for delivered hypochlorite would cover instances of peak demands occurring in a month, on-site generation needs to actually produce the required peak amount (i.e., with on-site generation peak days can not be averaged with days of lesser Cl_2 demands). This discrepancy is more pronounced for McMillan WTP, where a 70-ton Cl_2/month target (i.e., 4,667 lb/day) would not meet the peak historical usage of 5,350 lb/day. Therefore additional units must be provided. However the readily available and non-hazardous nature of salt (NaCl) compared to bulk sodium hypochlorite deliveries means that salt storage can be based on design flow and average chlorine dose (i.e., equivalent to about 100 tons Cl_2/month for Dalecarlia WTP, and 55 tons Cl_2/month for McMillan WTP).

Dalecarlia WTP

The needed transition from chlorine gas to sodium hypochlorite eliminates the use of the existing chlorine building to house on-site facilities at Dalecarlia. A new building is needed to incorporate the on-site generation of sodium hypochlorite and all its equipment and tanks.

The layout shows eleven sodium hypochlorite generators (one used for redundancy) each producing a maximum of 1,000 lb Cl_2 per day to meet the historical maximum daily usage of 9,630 lb Cl_2 at Dalecarlia WTP. The units can be juxtaposed and require 3-ft spacing from the wall and 5-ft clearance in the front. Adequate room is provided for operator movement and replacement of generators and ancillary equipment (i.e. water softeners, filters, heaters, pumps, and monitoring equipment). The ancillary equipment is arranged against the South wall of the new building bordering the present chlorine facility's North side.

With a design flow of 132 mgd and an average dose of 6.4 mg/L Cl_2, a month supply of salt would be about 635,000 lb NaCl (assuming 3.0 lb NaCl to produce 1.0 lb Cl_2). At a density of 135 lb/ft^3, the corresponding volume (4,700 ft^3) requires two 2,350-ft^3 tanks. The brine tanks (13-ft dia., and 18-ft high) sit on a common 1-ft thick pad with a surface of 15 ft by 30 ft. The two 160-ton brine tanks can be trucked-in instead of built in-place. The 10,000-lb Cl_2 maximum output of the generators would require 150,000 gallons of storage of the 0.8 percent hypochlorite solution for the recommended day supply, which is met with three 50,000-gal 25-ft dia., 14-ft high tanks.

McMillan WTP

For McMillan WTP, the objective was to layout the on-site generation equipment within the existing chloramine building, because McMillan WTP has the option of using Cl_2 gas from the chlorine building located on the North side during the transition.

The layout includes seven generators (one used for redundancy), each capable of producing 1,000 lb of chlorine per day, to meet McMillan's historical daily maximum usage of 5,350-lb Cl_2. Because of the anticipated 4 mgd increase in flow, the maximum daily amount was thus set at 6,000 lb. This would make the design capable of achieving the historical maximum demand plus a 12 percent increase. Ancillary equipment (i.e. water softeners, filters, heaters, pumps, and monitoring equipment) are also included in the layout.

All tanks used in the design may be trucked in to avoid built in-place tanks, though due to lack of space, the hypochlorite storage tanks will need to be replaced with built in-place tanks when they have reached the end of their design life. The brine tanks are designed for a month storage based on design flow of 74 mgd and an average chlorine dose of 5.8 mg/L corresponding to a daily usage of 3,582 lb Cl_2 or 162 tons of salt a month (assuming 3.0 lb NaCl to produce 1.0 lb Cl_2). Each brine tank is capable of holding 82 tons or 1,217 ft^3 of salt, allowing a total storage capacity of 164 tons. The brine tanks have a 10-ft diameter and stand 15.5-ft tall, both on a 1-ft thick pad. To accommodate the 6,000-lb Cl_2 maximum, a day supply of the 0.8 percent hypochlorite solution would require 90,000 gallons of storage, which would be accomplished with six 15,000-gal, 12-ft dia., 18-ft high tanks.

Redundancy Requirements

It is recommended that on-site generation rely on at least one back-up hypochlorite generator to take up work if another fails. A supplementary chlorine generator is shown on Dalecarlia WTP and McMillan WTP on-site layouts to provide redundancy. The back-up chlorine generator may be needed in emergency situations such as a generator down during high need, or to provide service while another is down for maintenance.

For unexpected power outages it is also recommended to have back-up power. Diesel or natural gas electrical generators should be implemented into the design if on-site generation is chosen. While natural gas may be cleaner and eliminate the need for fuel storage, if natural gas service is not available the diesel option should be selected.

STORAGE TANK MATERIALS AND METHOD OF CONSTRUCTION

The following materials of construction can be used for hypochlorite tank storage. (Chlorine Institute, 2006)

- Rubber-Lined Steel – Usually custom-fabricated to individual processes
- Fiberglass Reinforced Plastic– The effectiveness and life span of this material with sodium hypochlorite relies on resin type, storage temperature, and characteristics of the solution. A gel coat outer layer is recommended for UV protection, if tanks are stored outside
- High Density Polyethylene (HDPE) – The life expectancy of HDPE tanks or tanks with HDPE liners depends on resin type, fabrication technique, product temperature, trace metal contaminants in solution, and installation and piping connection methods
- Titanium Tanks – The associated long life (30 to 50 years) may offset the relatively high capital costs
- In addition, lined wood tanks can be used

Fiberglass reinforced plastic (FRP) tanks were selected for cost estimating purposes in this report, as they are the most commonly used material for storing hypochlorite, were used in all of EE&T's previous designs, and were used at all of the utilities used as case studies in the report. With FRP tanks, the curing process of thermoset resins can be affected by the temperature and humidity when assembling tanks in the field; therefore, tanks manufactured in a controlled environment tend to be more reliable than tanks assembled in the field. The cost of field-built vessels typically runs 150 to 200 percent higher per gallon than shop-built tanks. The cost differential can be greater depending on local conditions and constraints. When replacing damaged tanks, off the shelf tanks have the advantage of being readily available, whereas bringing a construction team to repair a field-built vessel may be more problematic.

FEED POINTS

Although degassing is less of an issue when storing 6 percent sodium hypochlorite, if commercially manufactured hypochlorite is used EE&T recommends that the system be designed to prevent vapor locking of the pumps from off-gassing or that pumps specifically designed for high concentration hypochlorite be used. Other successful methods are also available for preventing vapor lock and excessive pressures, such as peristaltic pumps, true-union valves, and flanged end valves due to their control capabilities, seal materials, and durability. De-gassing is less of a concern if an on-site sodium hypochlorite generation system is used, due to the low concentration of the generated solution. The two sections below address feed points for each plant.

McMillan WTP

Chlorine at McMillan WTP is injected at three points in the treatment plant. Injection points include the pre-chlorination point, post-chlorination point, and the North clearwell effluent. Pre-chlorination takes place in the settled water channel, delivered by a 6-in. diameter pipe feeding two 4-in. diameter diffusers. The post-chlorination takes place in the lime mixing chamber where a 2.5-in. pipe feeds three 2.5-in. diffusers.

Regardless of its stored concentration (6 or 12 percent), the sodium hypochlorite would be injected into carrier water before being transported to the feed point. Concentration in the feed line should be designed to not exceed a 0.8 percent concentration, though the concentration will vary over time depending on the ratio of flow rate of the concentrated sodium hypochlorite and the flow rate of the carrier water. Unlike dilution of 12 percent sodium hypochlorite to 6 percent, the ratio of hypochlorite to the carrier water will never be large enough to significantly raise the pH in the carrier water piping. Therefore, no special accommodations are needed to prevent calcium carbonate precipitation in the carrier water piping. If on-site generation of hypochlorite is utilized no carrier water would be needed, as the solution strength produced on-site would already be at 0.8 percent.

The existing piping was evaluated for its capacity to convey the maximum predicted usage of 6,000 lb of Cl_2 per day, which corresponds to 94,000 gpd of NaOCl at 0.8 percent. Maximum velocities are encountered in the 2.5-in. piping, where conveying the entire flow would create a velocity of 4.25 fps. Carrier water for chlorine is fed by four 4-in. pipes, each one capable of handling the maximum dilution water needed (i.e., worst case being the dilution of 12 percent liquid hypochlorite).

Dalecarlia WTP

Chlorine stored at Dalecarlia WTP can be injected at five points within the Dalecarlia process and also at one point in the Georgetown conduit which is conveying McMillan source water. The five points within the Dalecarlia process include:

- Parshall flumes (4 lines)
- East and West sedimentation basin effluents
- Filter effluent
- Effluents of both clearwells

Lines running from the chlorinators to the injection points within Dalecarlia WTP have 4-in. diameter and 6-in. diameter diffusers. The line running from three chlorinators to the Georgetown conduit steps up from a 4-in. to a 6-in. diameter pipe.

As with McMillan, the hypochlorite will be delivered as an approximately 0.8 percent solution regardless if it is stored at 12 percent, 6 percent, or generated on-site. Assuming a maximum daily usage of 10,000 lb Cl_2, the total solution would be in excess of 150,000 gpd which corresponds to a flow of about 110 gpm. This flow through one 4-in. pipe (i.e., worst case scenario) would result in a fluid velocity of 2.8 fps, which is within the recommended range of pipe velocities. This means that piping from the chlorinators to the injection points for the present disinfection system could accommodate the hypochlorite solution.

TRUCK DELIVERIES

Consideration of new traffic associated with each alternative at both plants is important, particularly in light of the community's interest regarding this issue in previous projects. Figures 2.5 and 2.6 both show an average monthly usage vertical line that determines the corresponding deliveries in a typical month for Cl_2 gas, delivered hypochlorite, and on-site hypochlorite (i.e., salt). While 12 percent or 6 percent hypochlorite will make a difference in storage demands, the number of deliveries per month will inherently be the same (i.e., 6 percent hypochlorite is from on-site dilution of 12 percent hypochlorite) and are thus both represented by the 12 percent line on Figures 2.5 and 2.6. The on-site generation option requires only salt (NaCl) to be delivered.

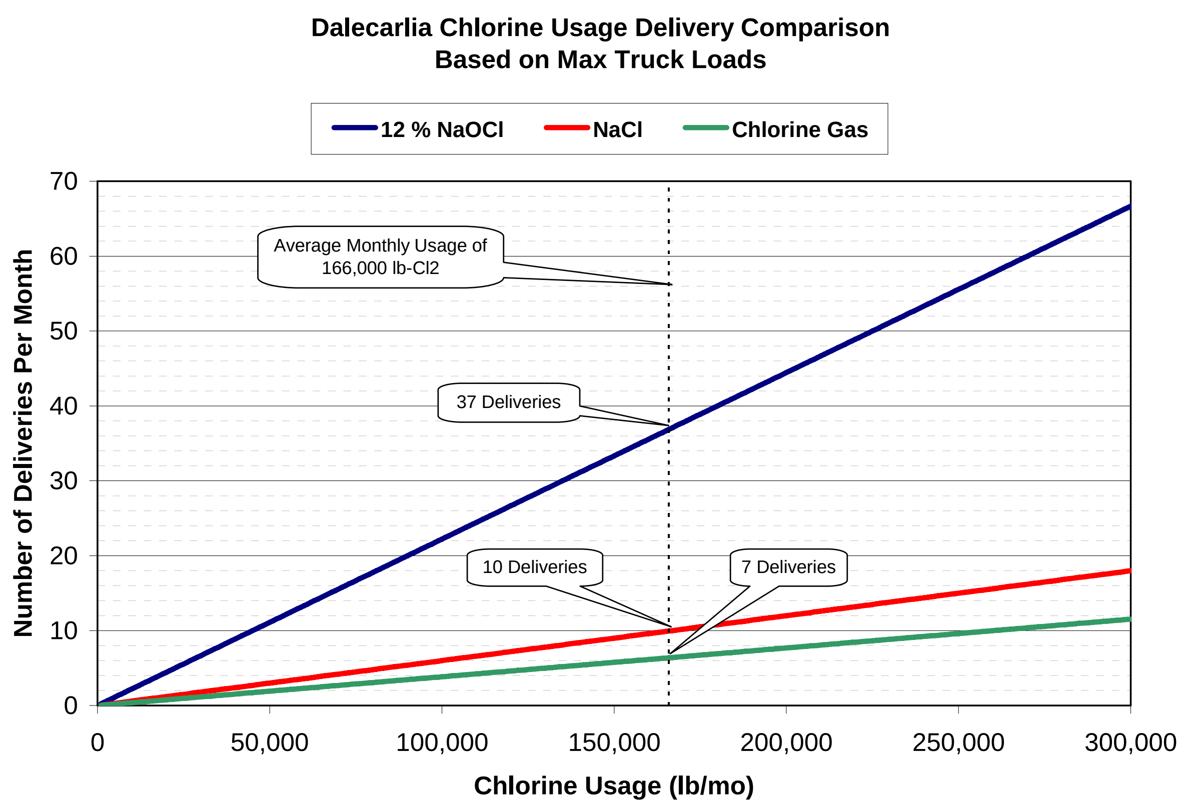


Figure 2.5 Delivery frequency between disinfection options for Dalecarlia WTP

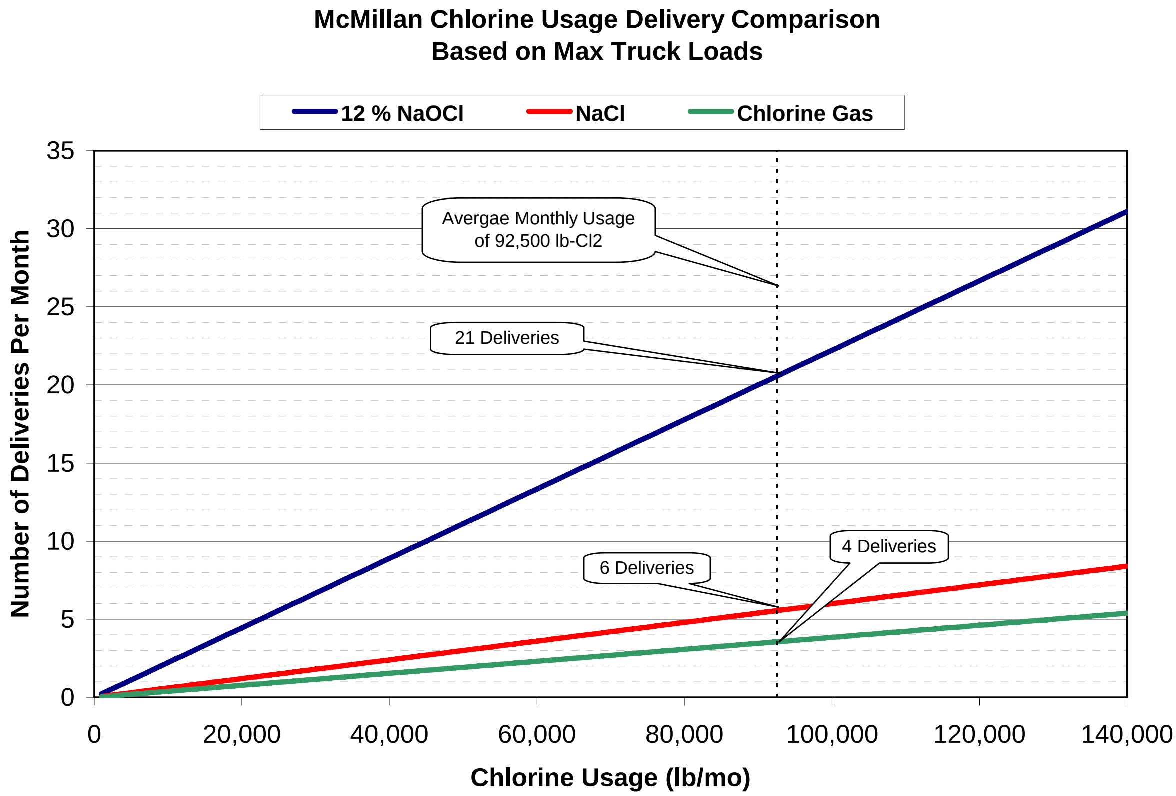


Figure 2.6 Delivery frequency between disinfection options for McMillan WTP

The 12 percent hypochlorite is delivered with a maximum load of 4,500 gallons equivalent to 4,500 lb of Cl_2 (1 gal-12% NaOCl = 1 lb Cl_2). The NaCl is delivered in 25-ton truck loads where every 3 lb of NaCl equates 1 lb Cl_2. Trucks delivering chlorine gas (Cl_2) have a maximum truck load of 13 tons.

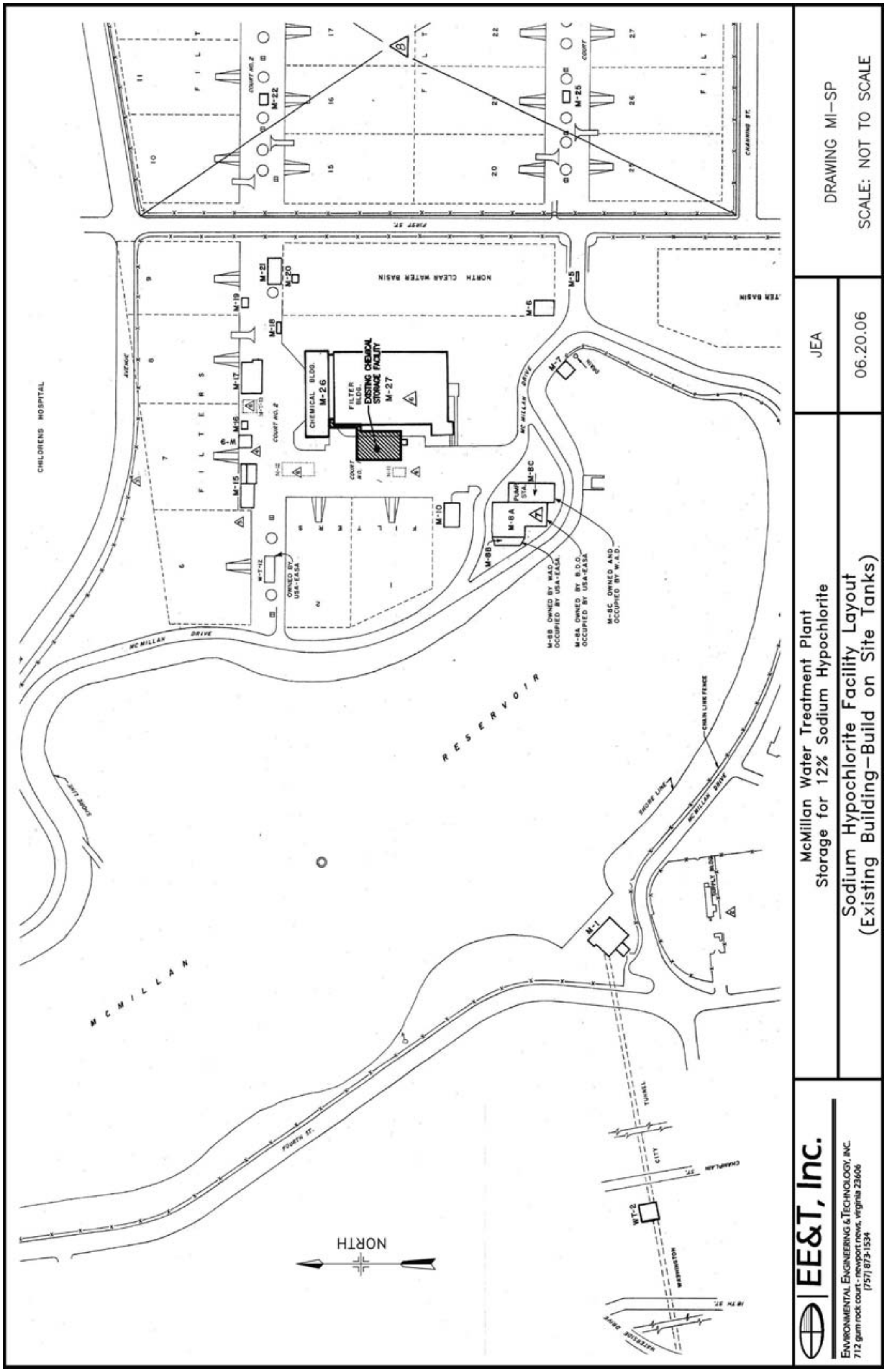
Figures 2.5 and 2.6 show that, regardless of the hypochlorite option selected, truck deliveries will increase compared to using chlorine gas. However, the increase in truck deliveries needed for on-site generation is relatively minor, compared to the larger increase in truck delivery frequency required if bulk-hypochlorite is delivered.

CLIMATE CONTROL

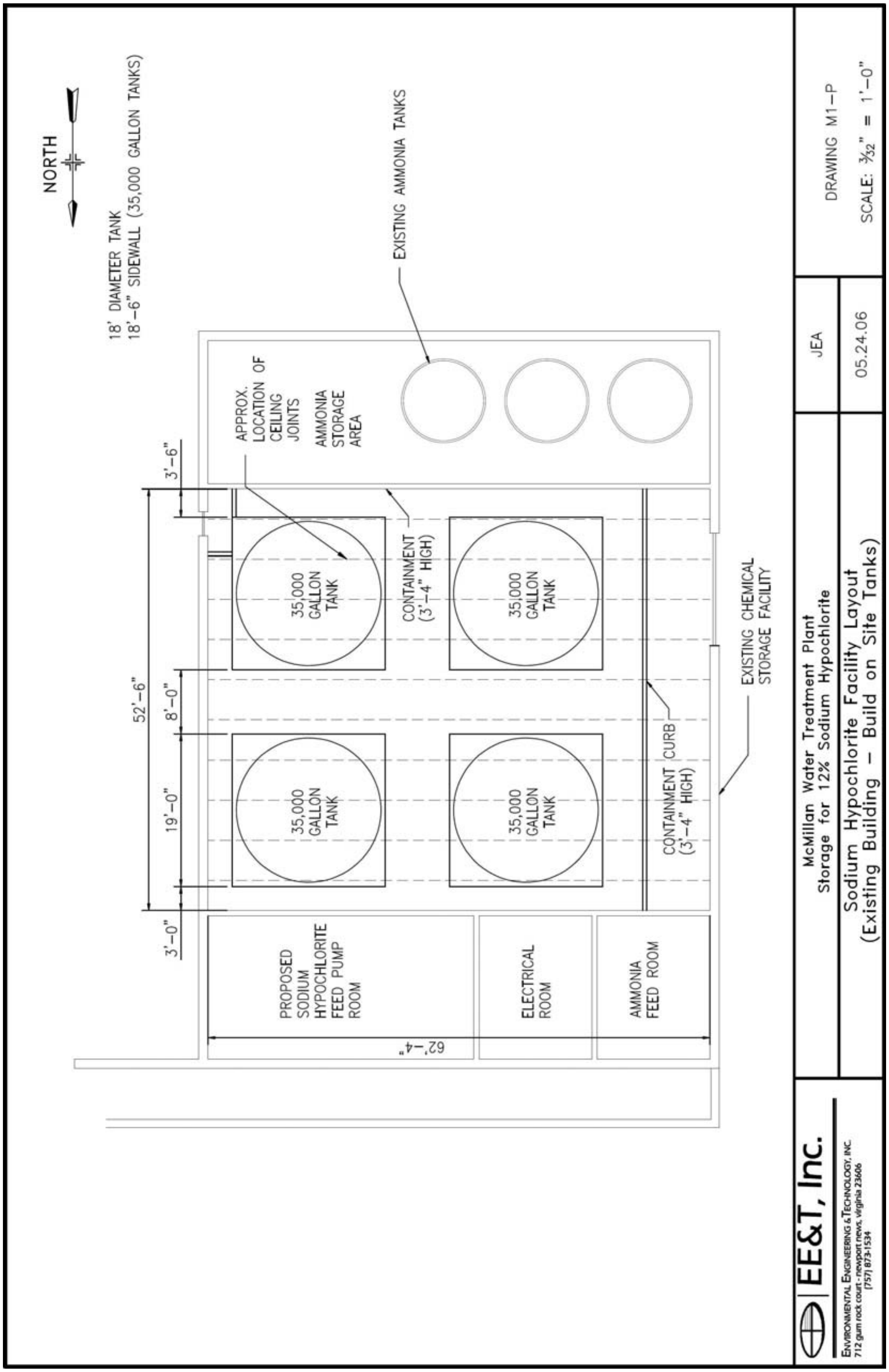
Climate control is primarily a concern when storing 12 percent sodium hypochlorite. At this concentration, warm temperatures (35^{o}C) will result in the greatest loss in hypochlorite strength (one-third of the concentration is lost after 28 days, from 12 to 7.9 percent). Therefore, climate control is needed when hypochlorite is stored at 12 percent to maintain the temperature at or below 20^{o}C, which will result in less than 7 percent loss of strength after 28 days.

At lesser initial concentrations (e.g., 6 percent), the temperature effect on NaOCl degradation is less drastic and therefore climate control becomes less critical. However, for worker's comfort, many utilities still provide air conditioning for dilute solutions at about 20ºC.

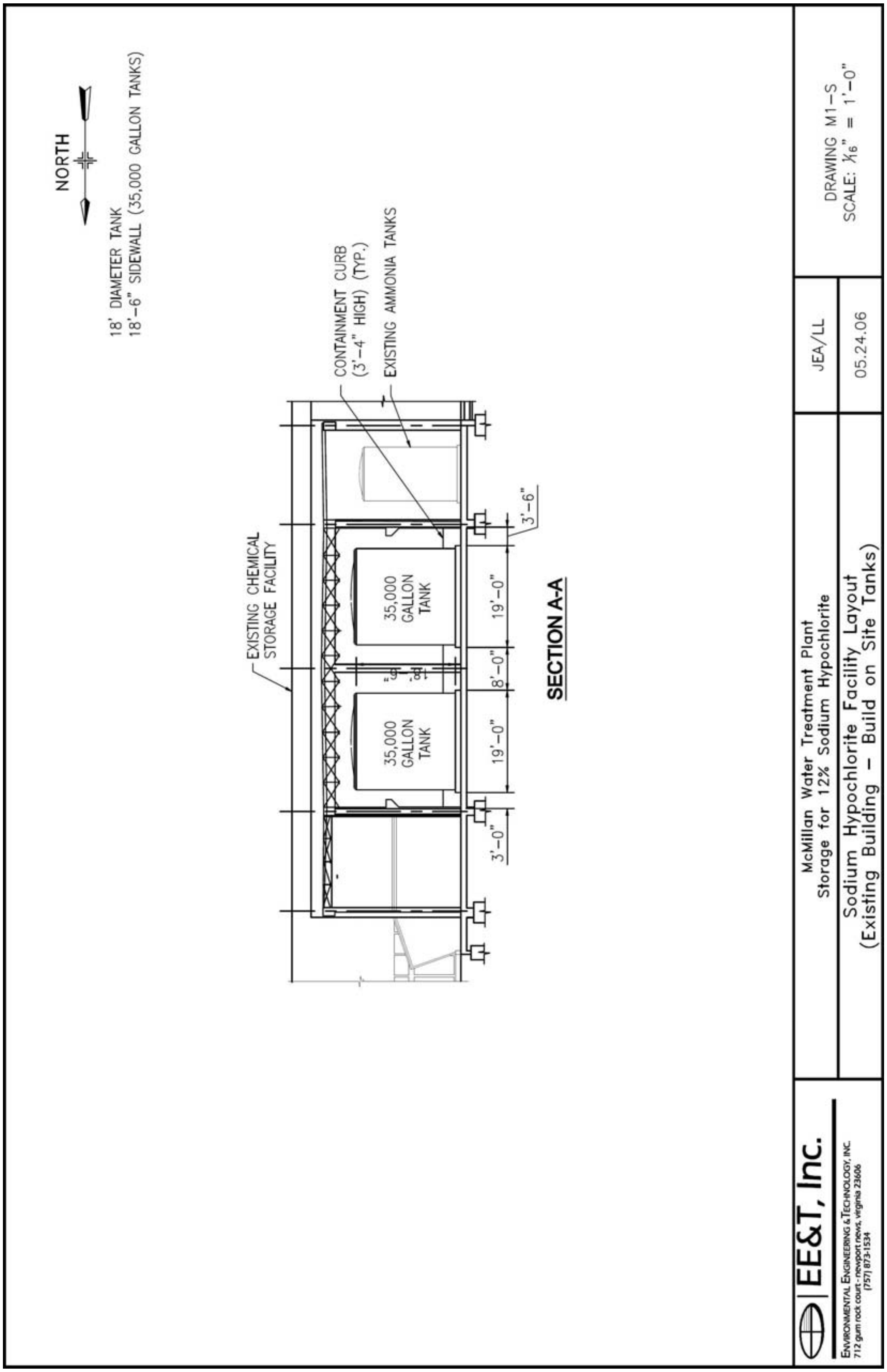
We recommend that storage for all buildings have HVAC, however for 6 percent solution this is only required for worker comfort. If 6 percent solution is used, the Washington Aqueduct could store the sodium hypochlorite at a higher temperature to reduce power consumption during the summer. For storage of 12 percent sodium hypochlorite we recommend a temperature be maintained below 20°C and the solution be stored only as necessary. In other words, when chlorine demands or plant flows are low, the tanks should not be fully utilized. We recommend in either case that delivered solution temperature be a part of the purchase specifications to avoid the delivery of freshly made (hot) sodium hypochlorite.



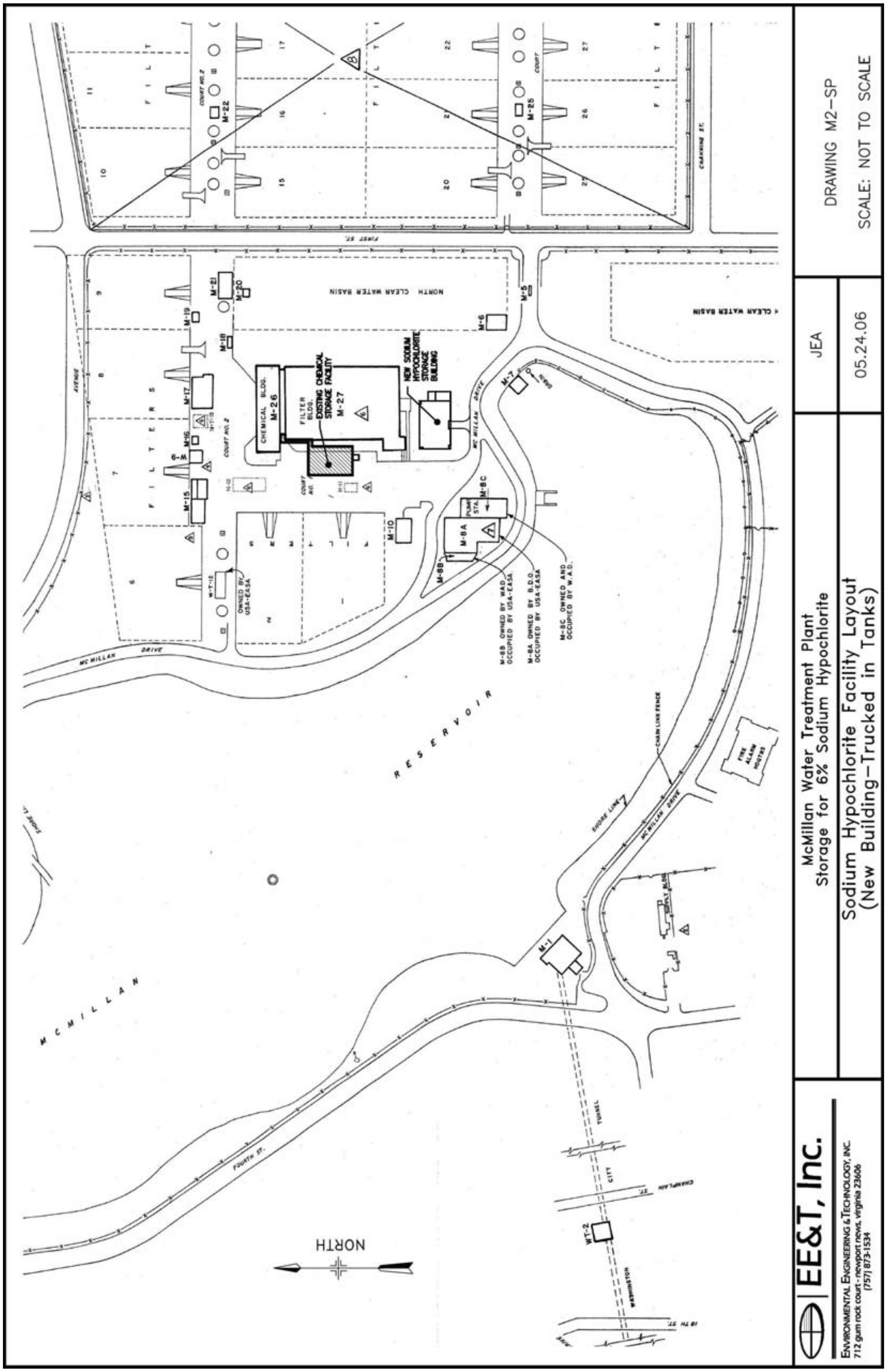
Drawing M1-SP: Site plan, McMillan, 12 percent sodium hypochlorite, 18’ dia. tanks



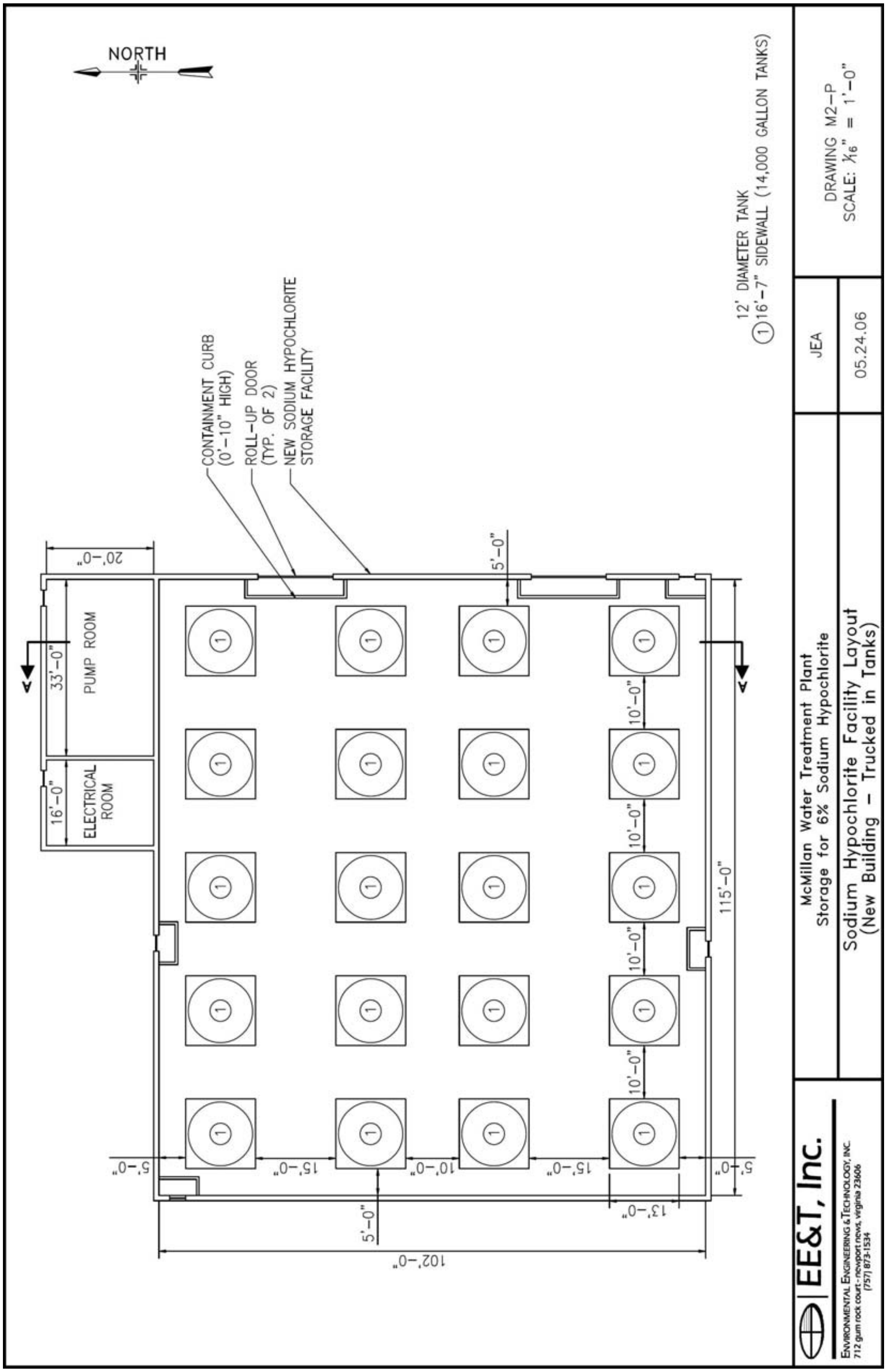
Drawing M1-P: Plan view, McMillan, 12 percent sodium hypochlorite, 18' dia. tanks



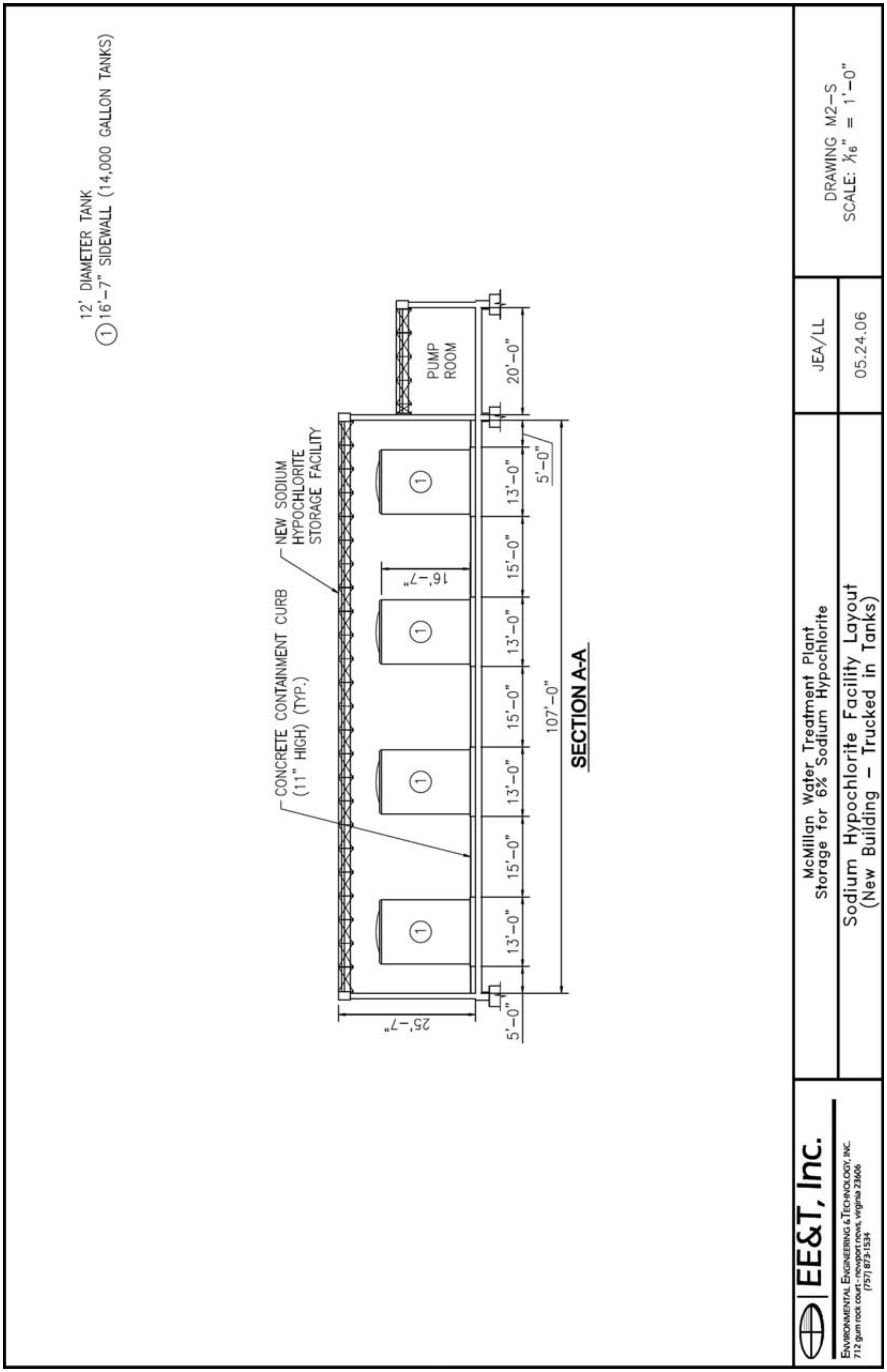
Drawing M1-S: Section, McMillan, 12 percent sodium hypochlorite, 18' dia. tanks



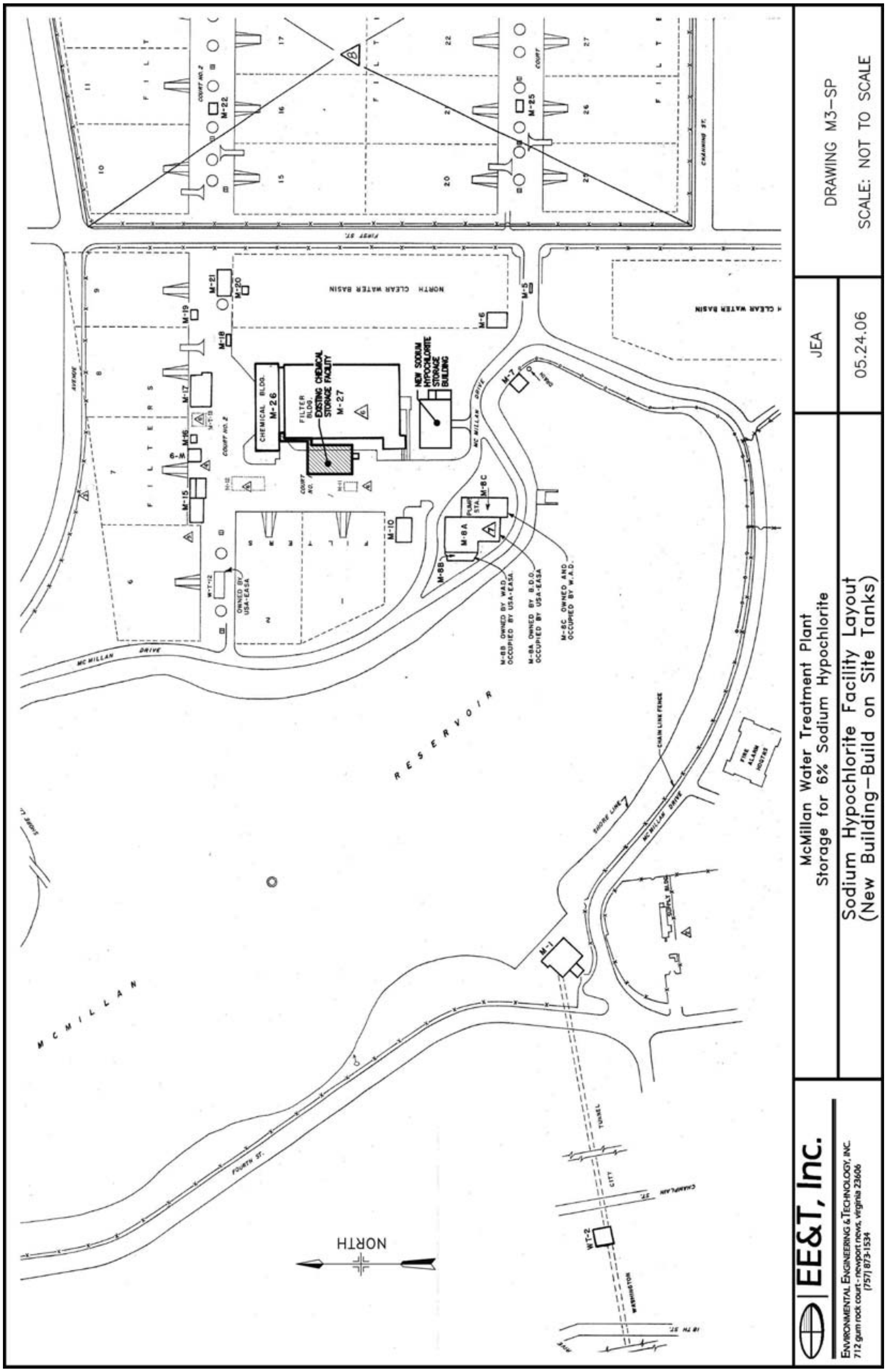
Drawing M2-SP: Site plan, McMillan, 6 percent sodium hypochlorite, 12’ dia. tanks



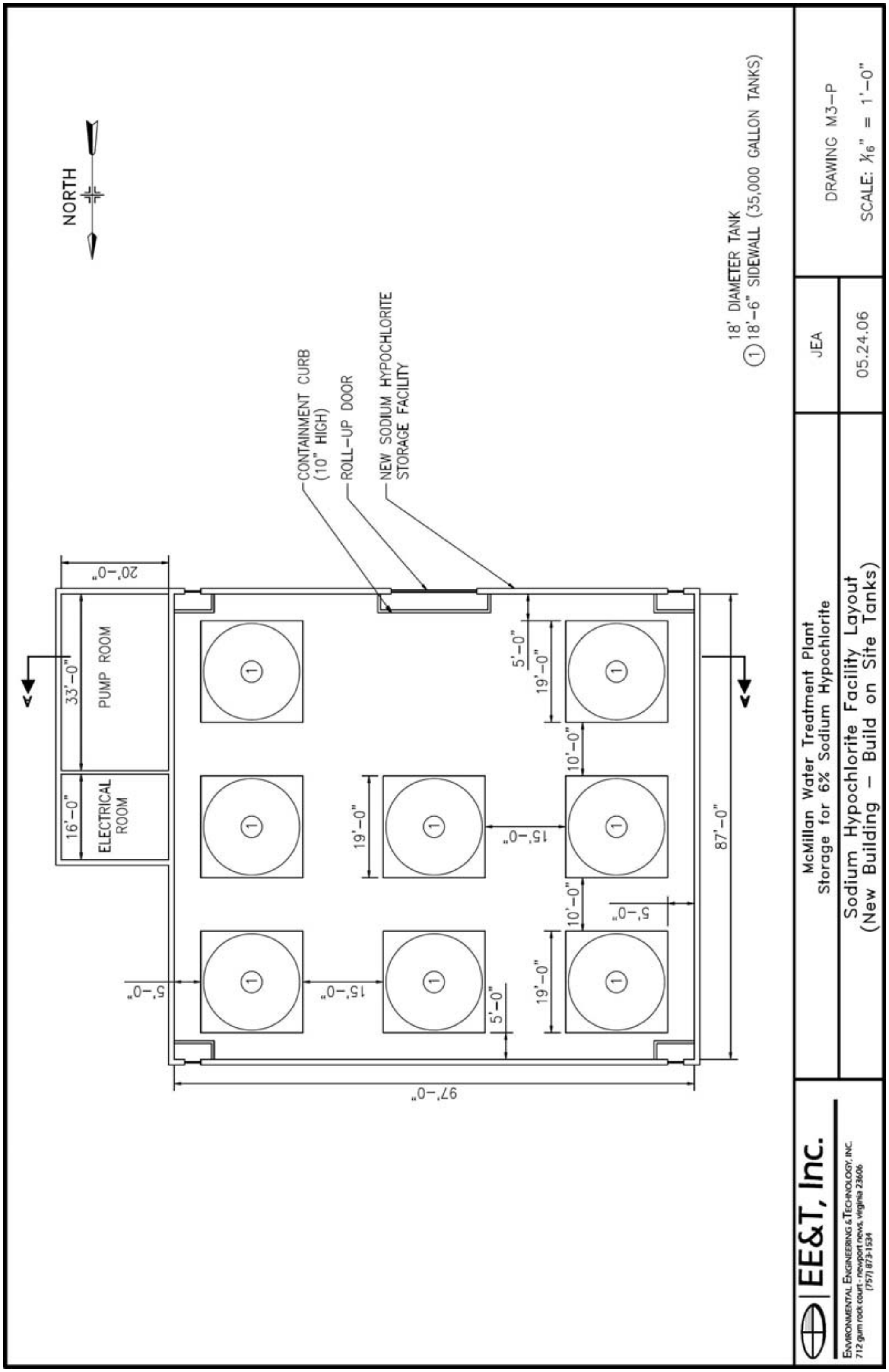
Drawing M2-P: Plan view, McMillan, 6 percent sodium hypochlorite, 12' dia. tanks



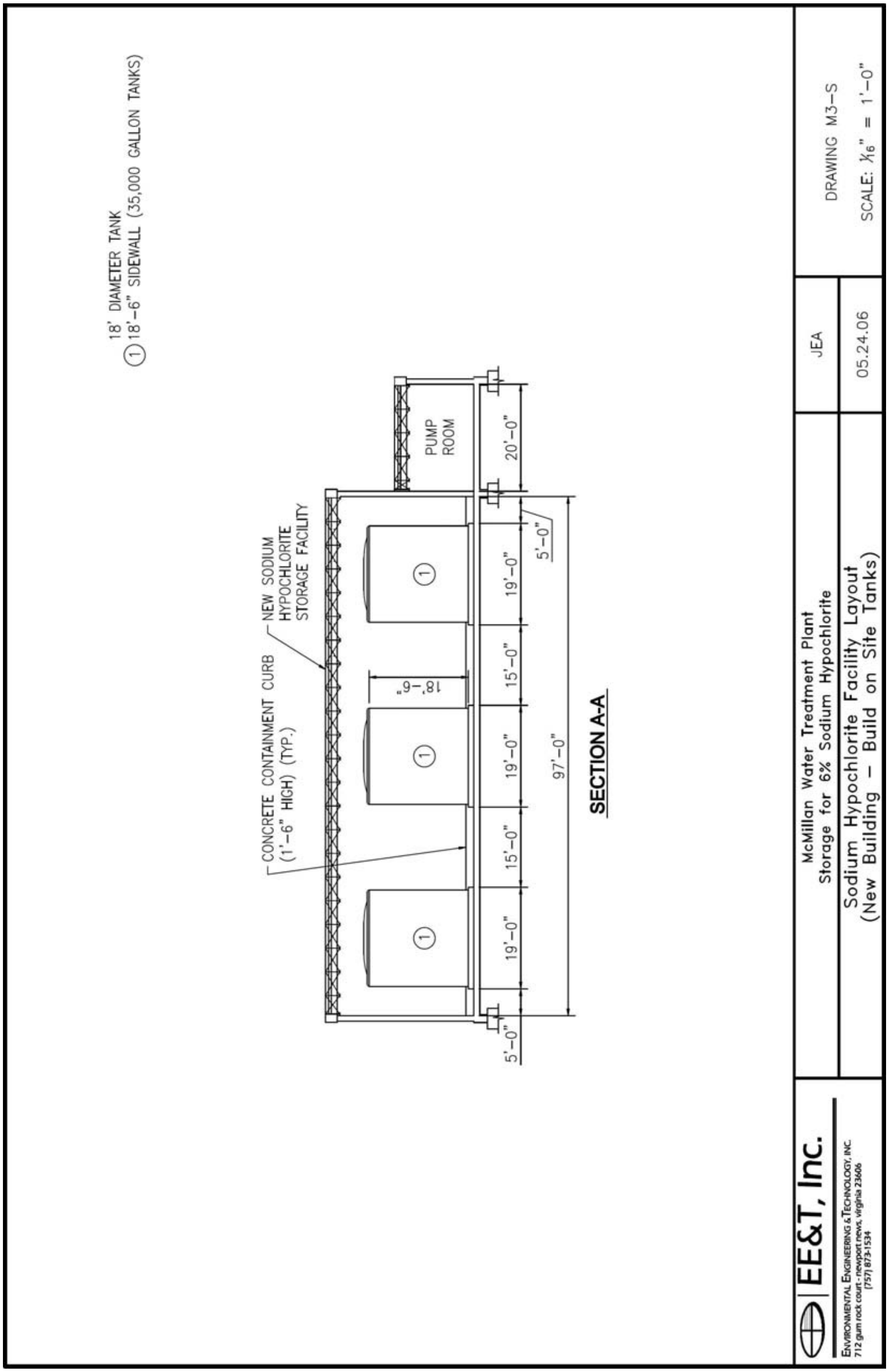
Drawing M2-S: Section, McMillan, 6 percent sodium hypochlorite, 12' dia. tanks



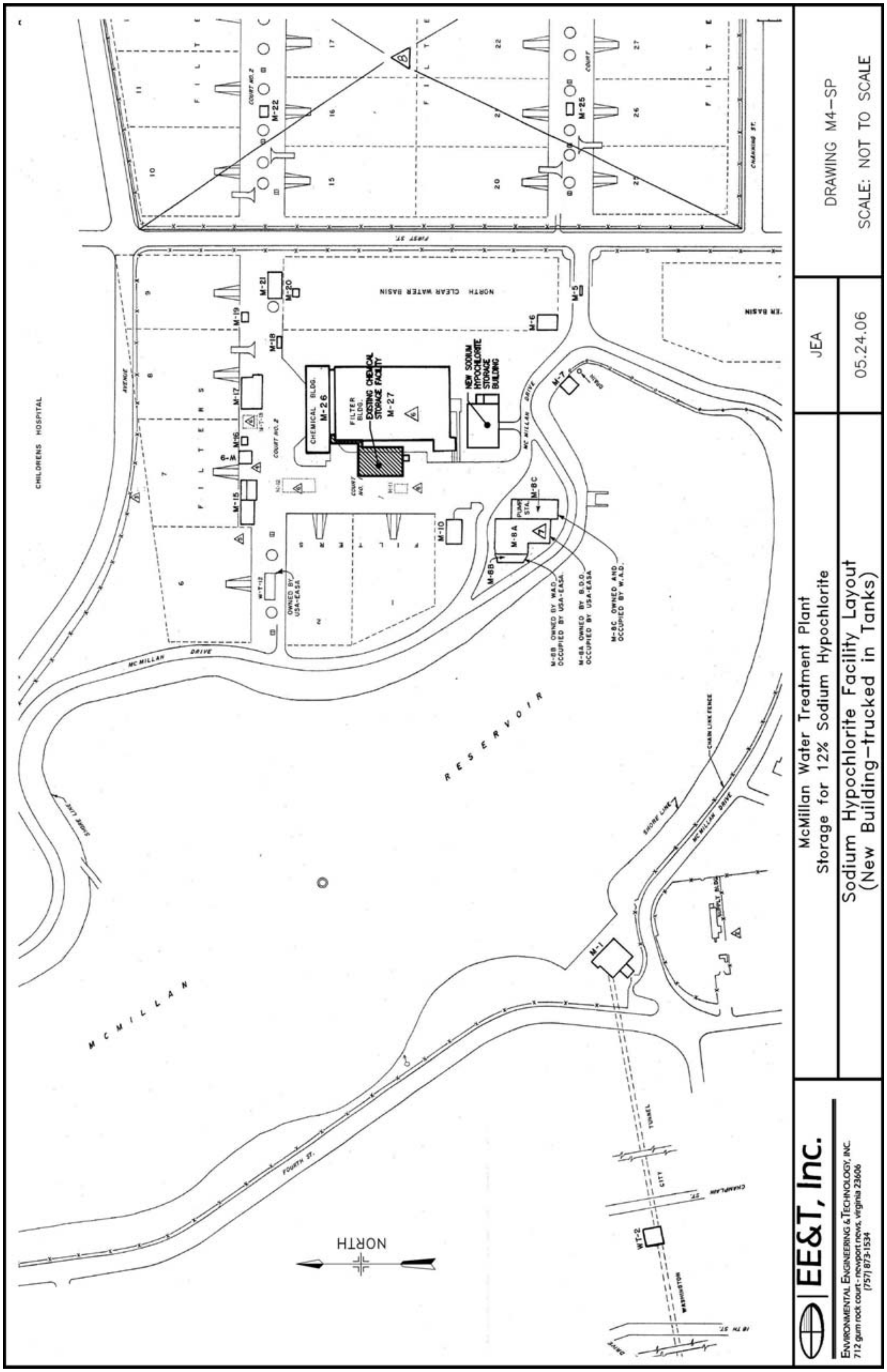
Drawing M3-SP: Site plan, McMillan, 6 percent sodium hypochlorite, 18’ dia. tanks



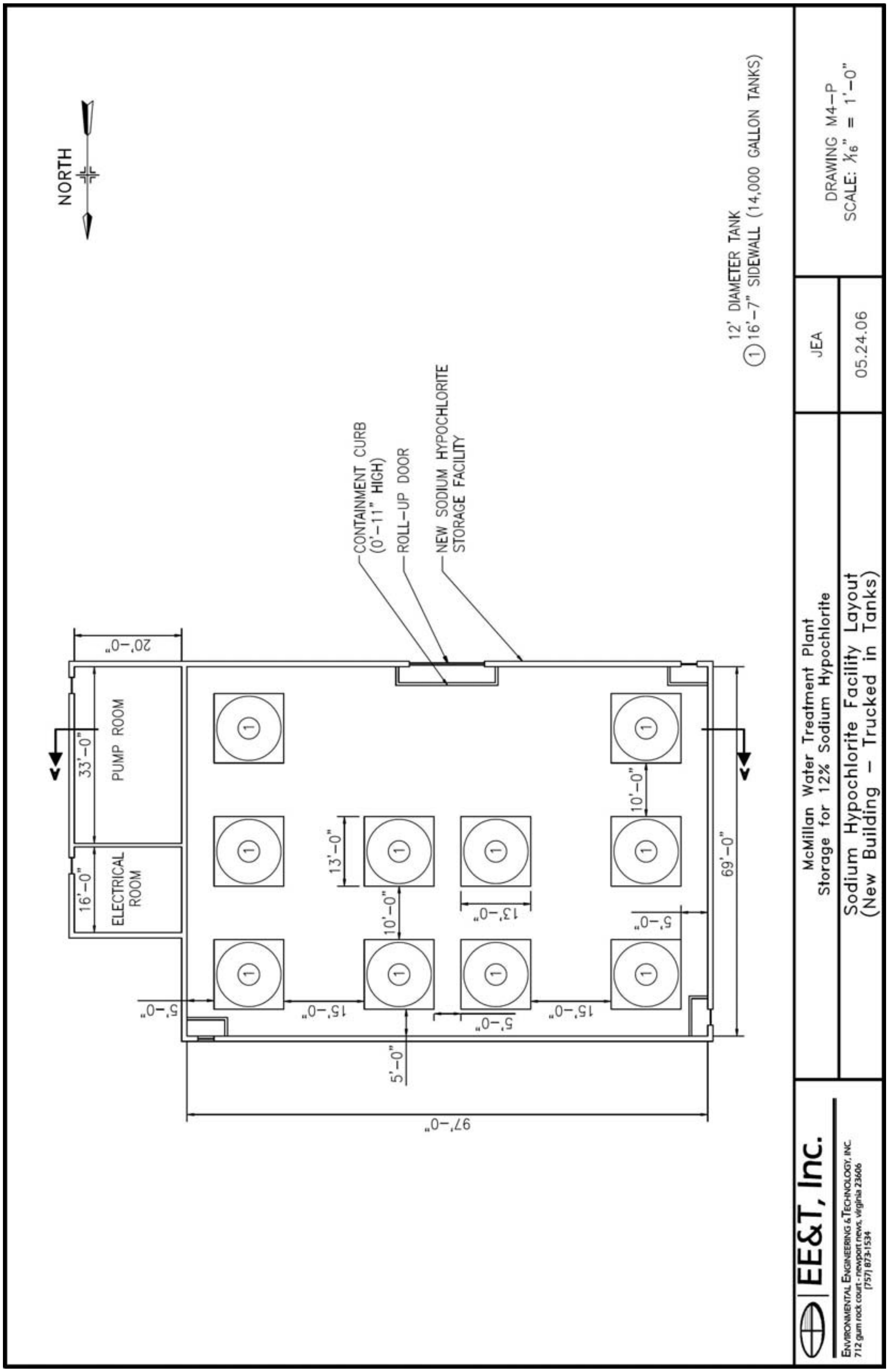
Drawing M3-P: Plan view, McMillan, 6 percent sodium hypochlorite, 18' dia. Tanks



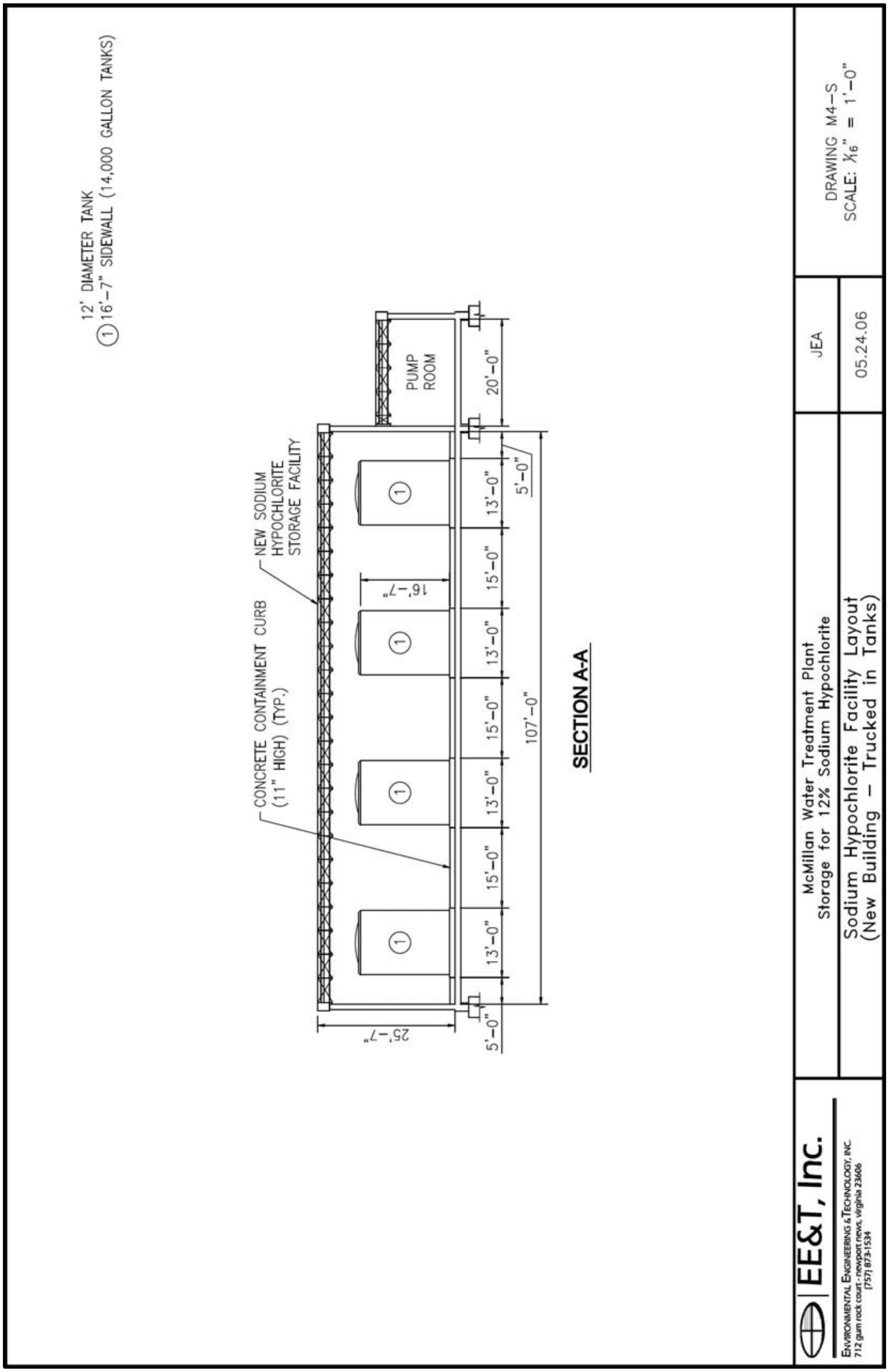
Drawing M3-S: Section, McMillan, 6 percent sodium hypochlorite, 18' dia. tanks



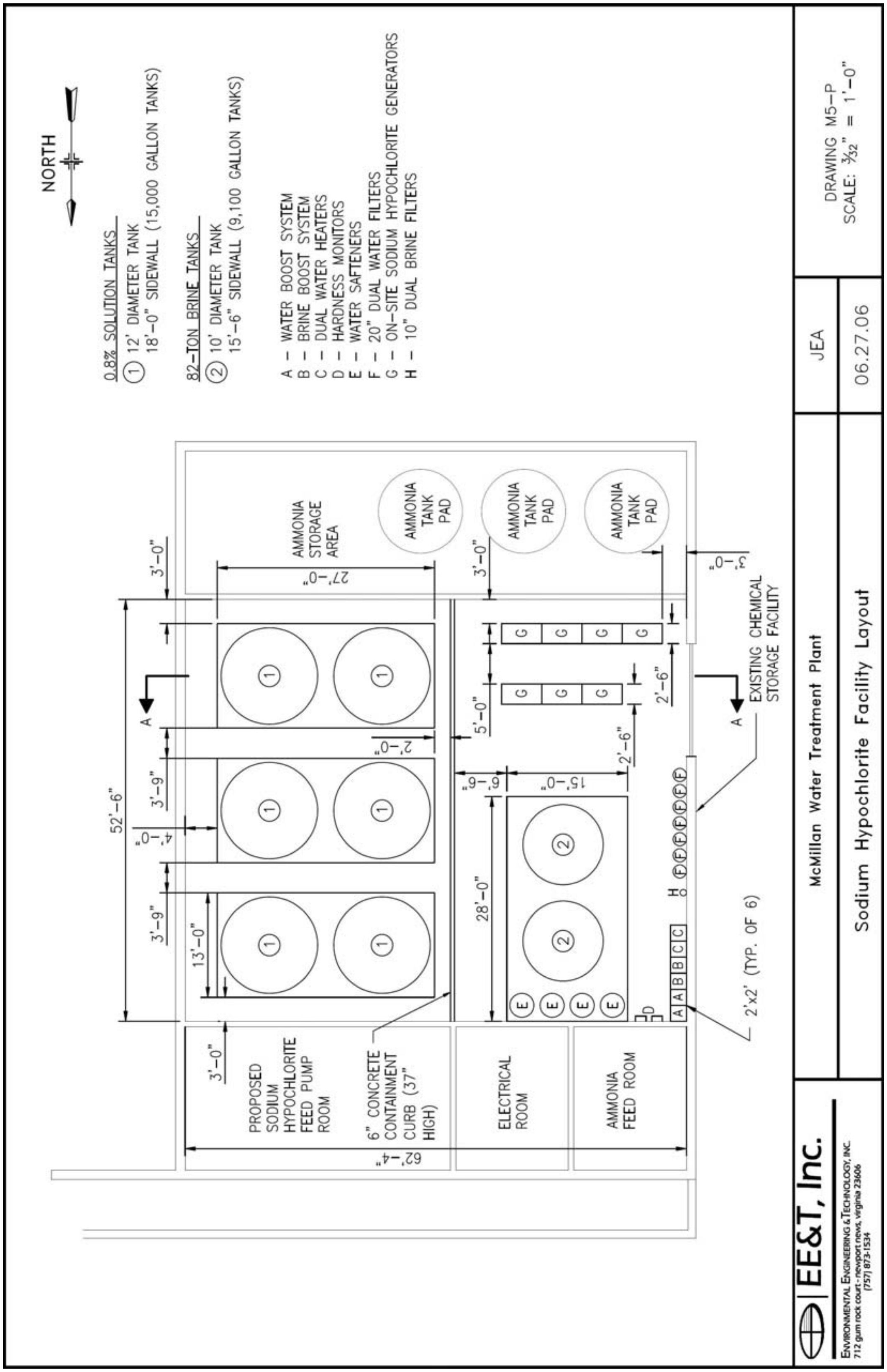
Drawing M4-SP: Site plan, McMillan, 12 percent sodium hypochlorite, 12’ dia. tanks



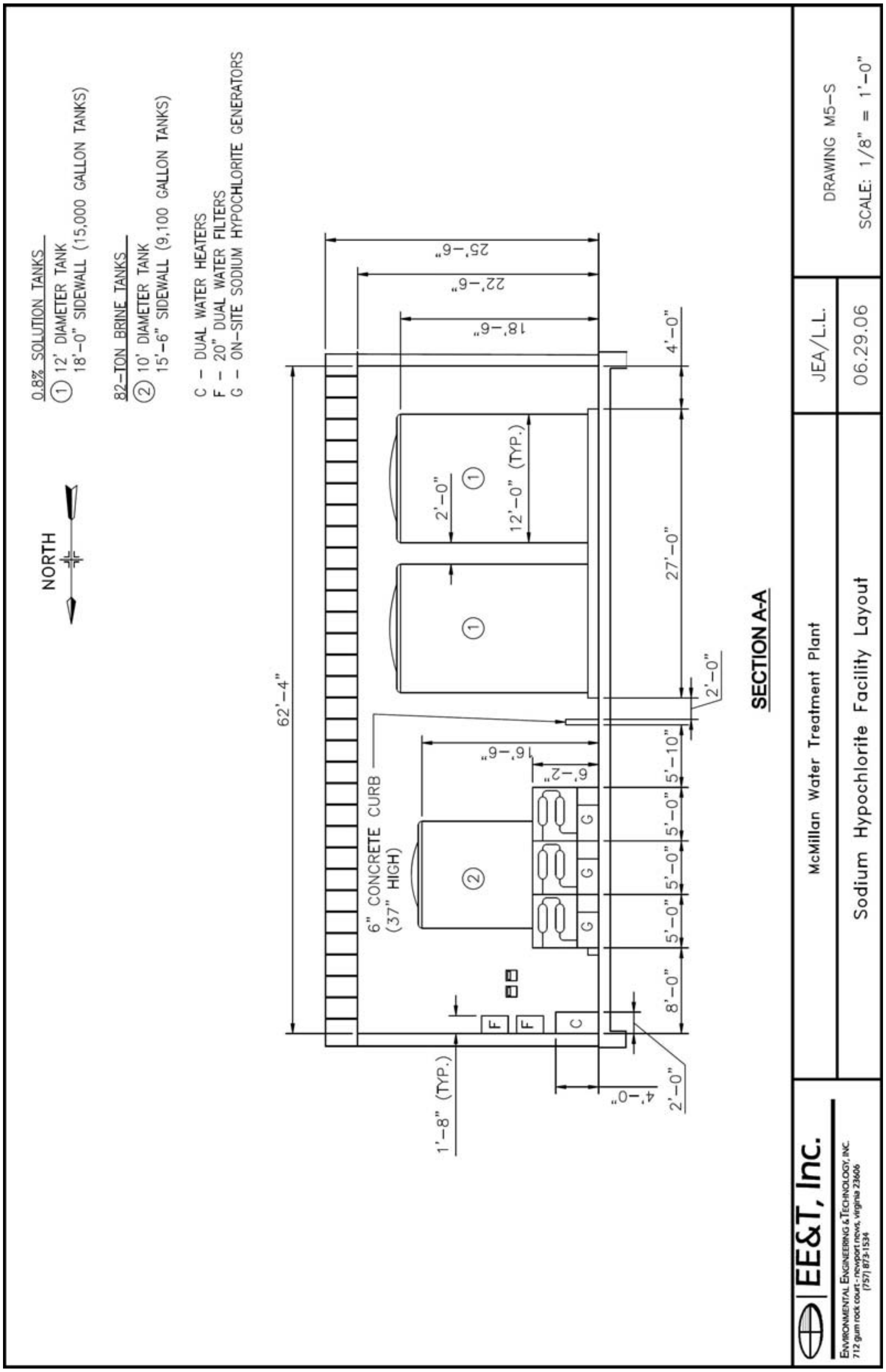
Drawing M4-P: Plan view, McMillan, 12 percent sodium hypochlorite, 12' dia. tanks



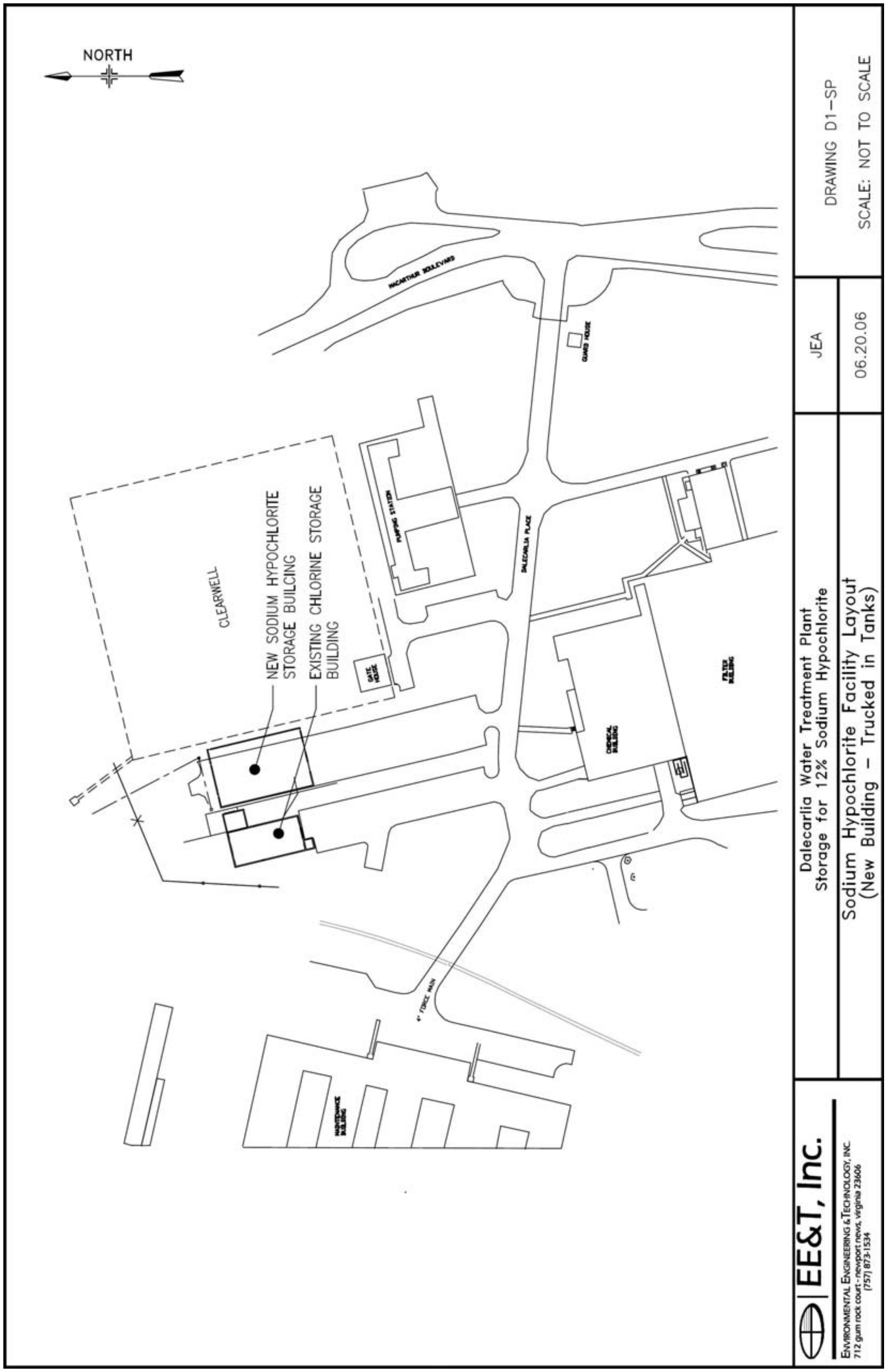
Drawing M4-S: Section, McMillan, 12 percent sodium hypochlorite, 12' dia. tanks



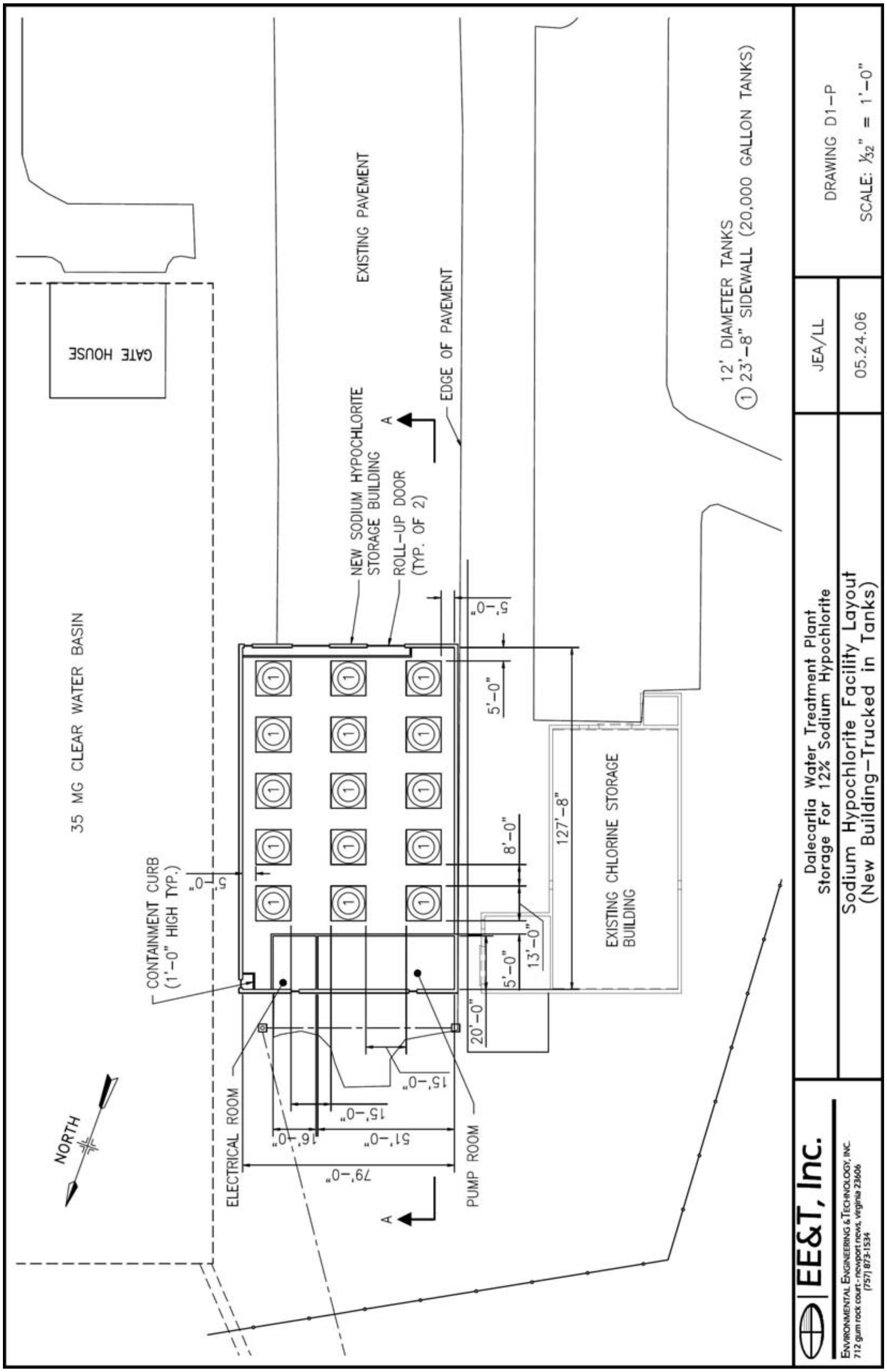
Drawing M5-P: Plan view, McMillan, on-site generation of sodium hypochlorite



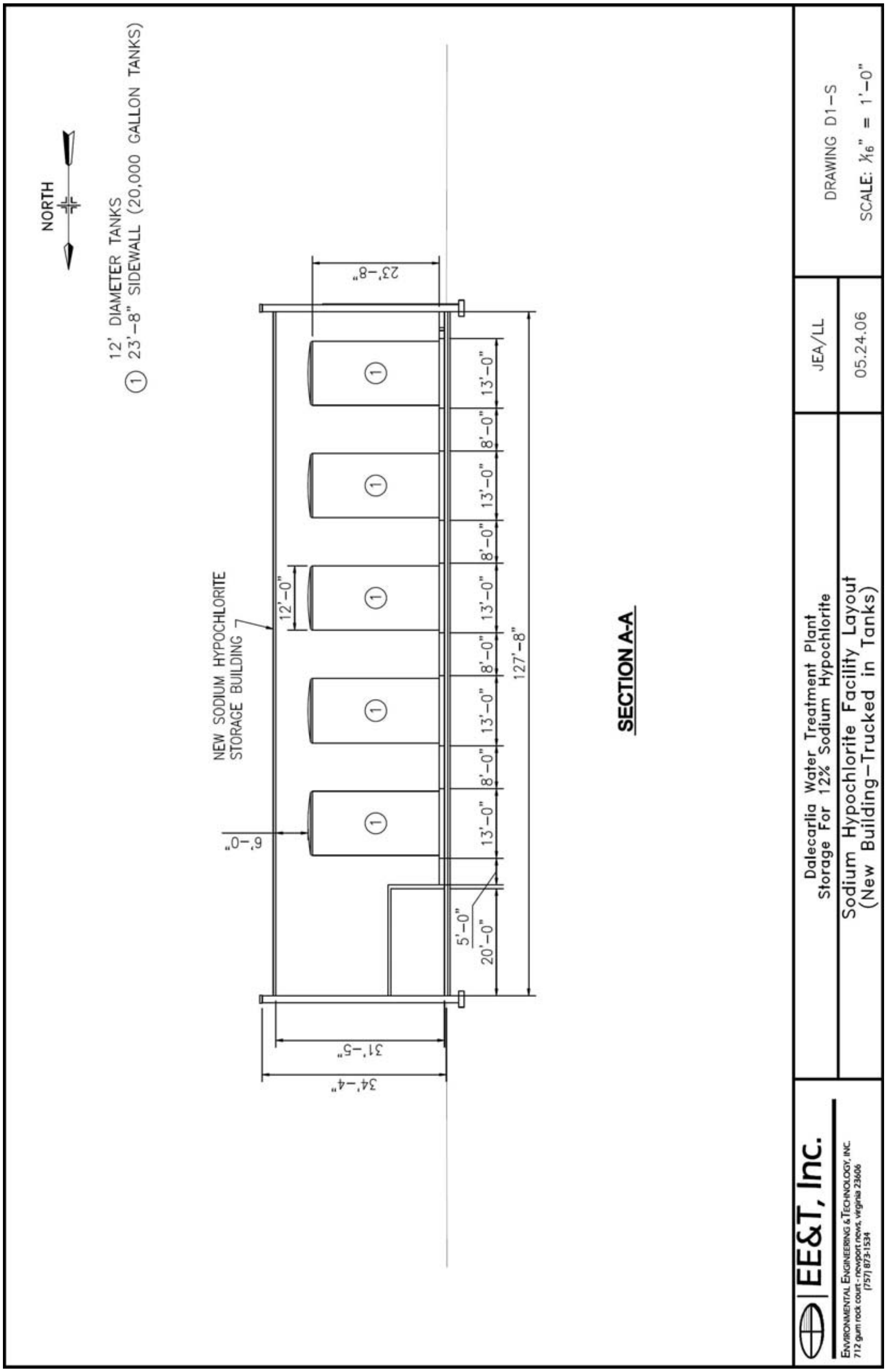
Drawing M5-S: Section, McMillan, on-site generation of sodium hypochlorite



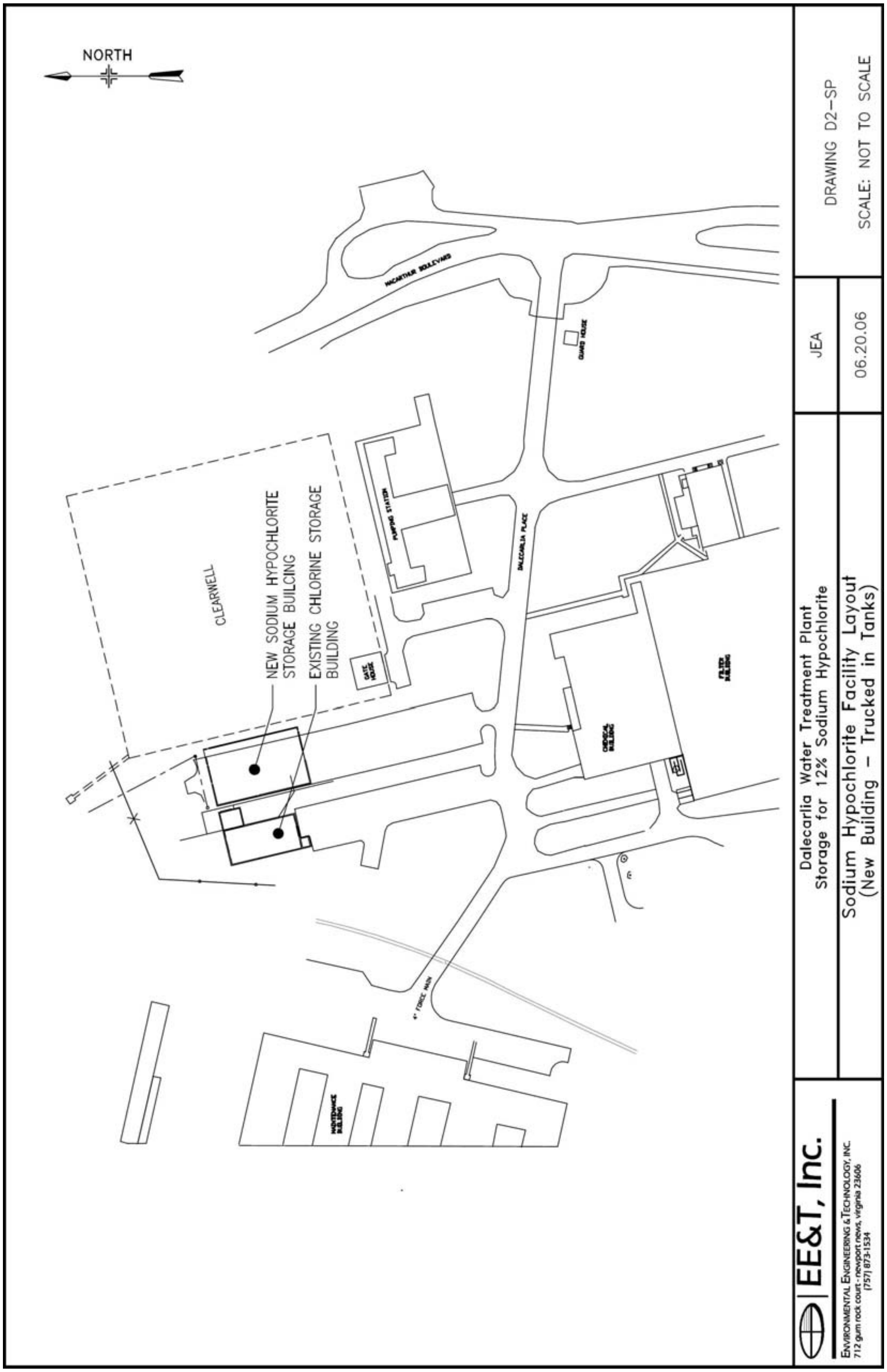
Drawing D1-SP: Site plan, Dalecarlia, 12 percent sodium hypochlorite, 12' dia. tanks



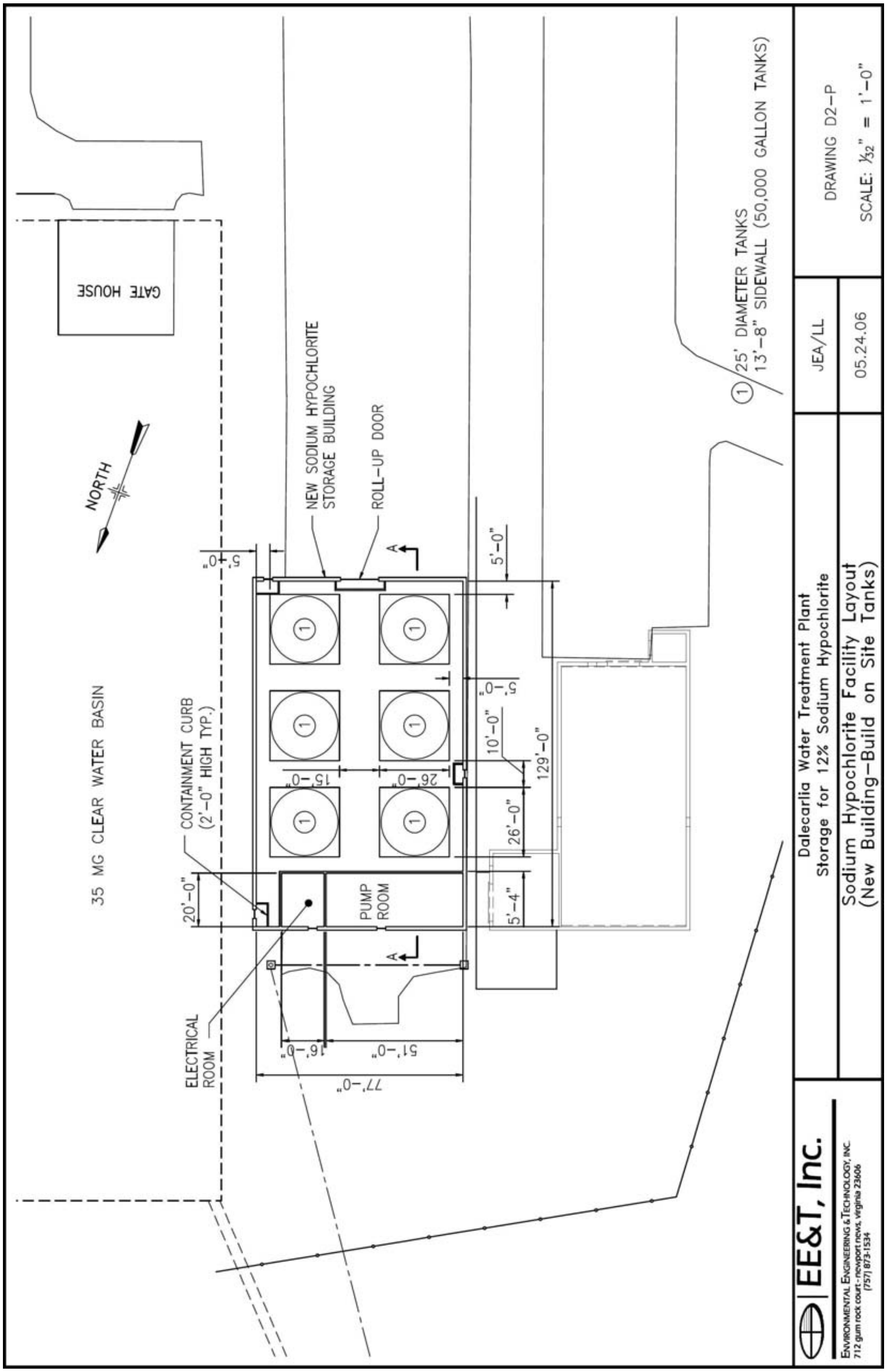
Drawing D1-P: Plan view, Dalecarlia, 12 percent sodium hypochlorite, 12' dia. tanks



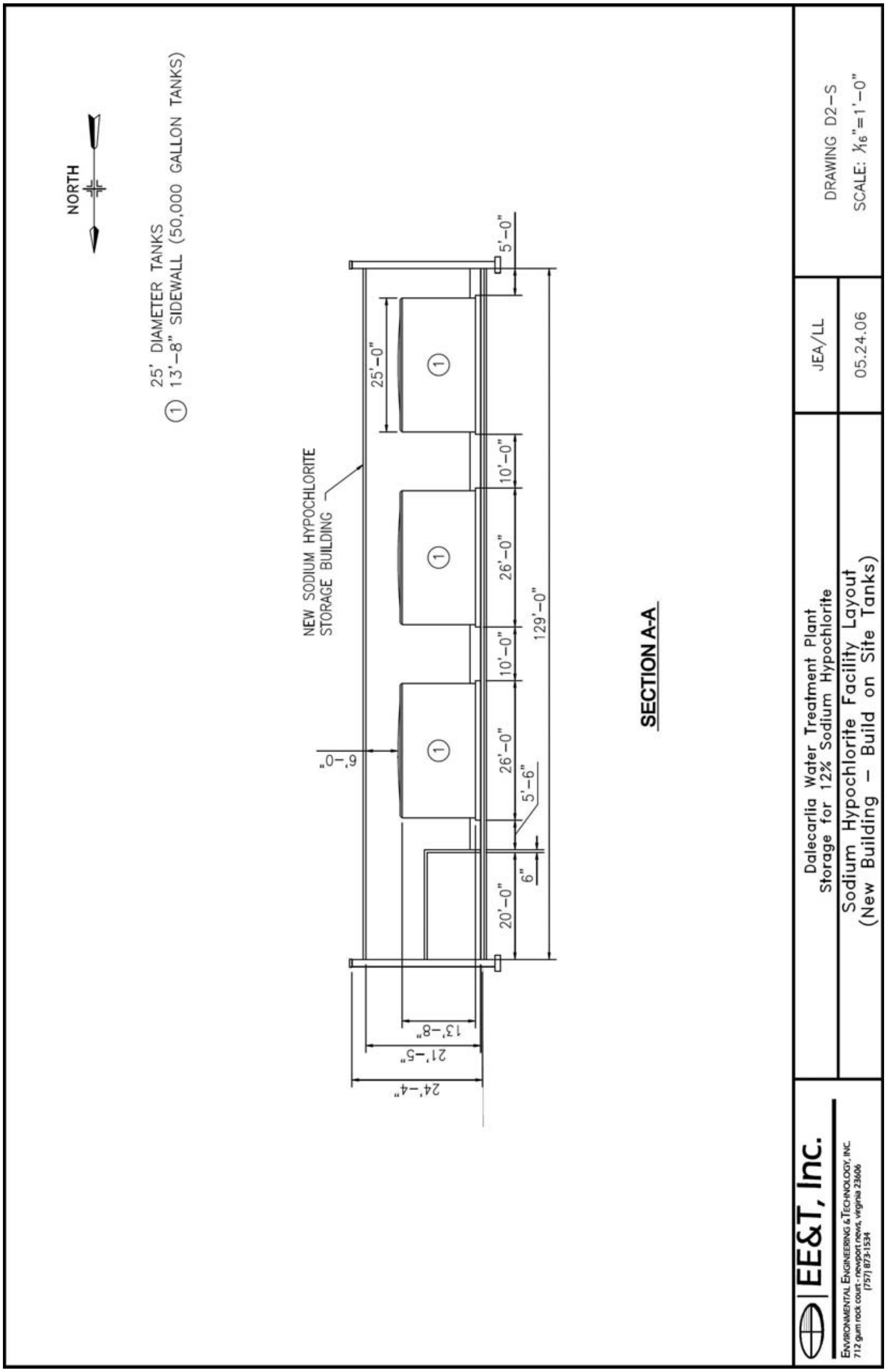
Drawing D1-S: Section, Dalecarlia, 12 percent sodium hypochlorite, 12' dia. tanks



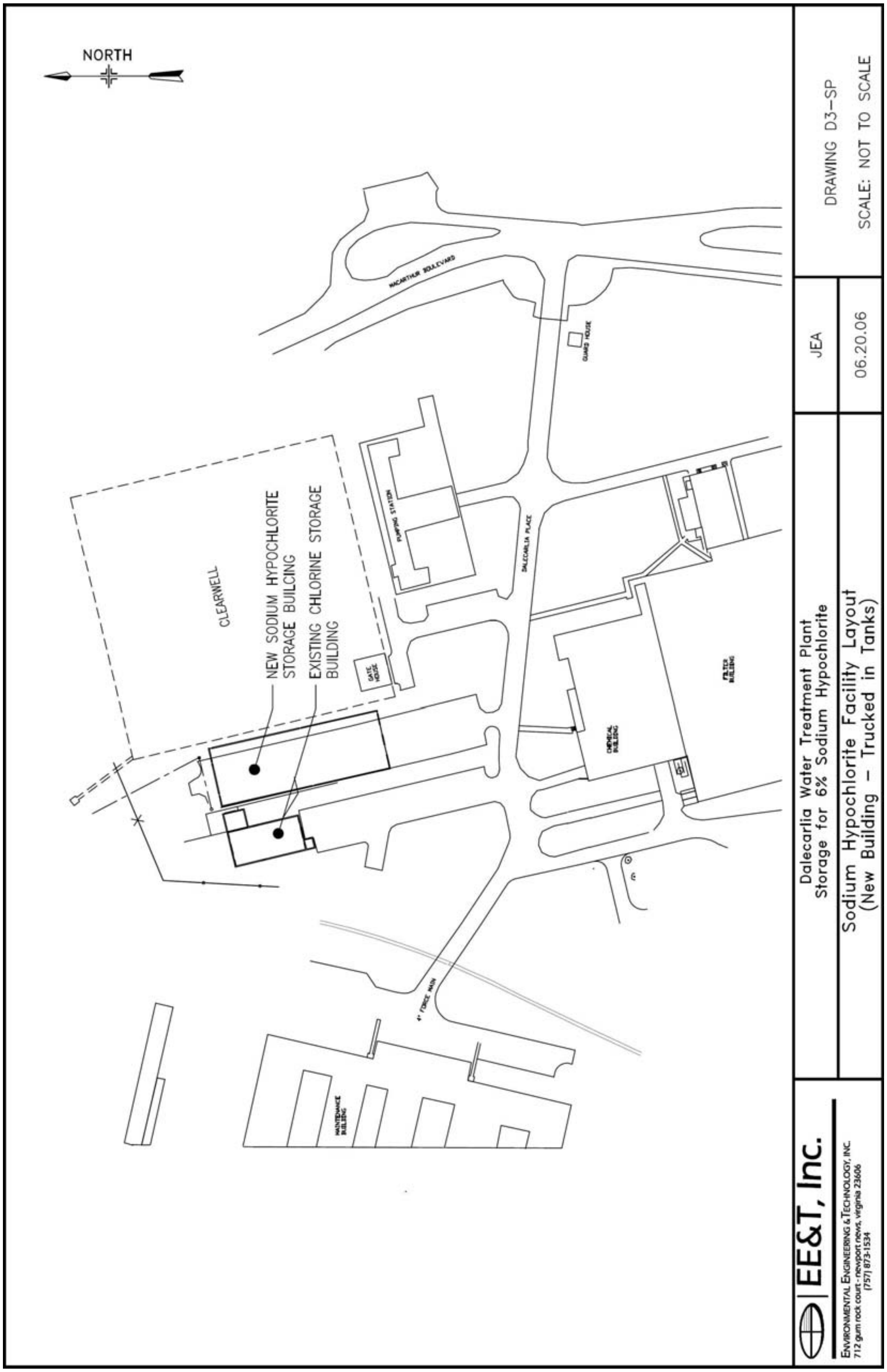
Drawing D2-SP: Site plan, Dalecarlia, 12 percent sodium hypochlorite, 25' dia. tanks



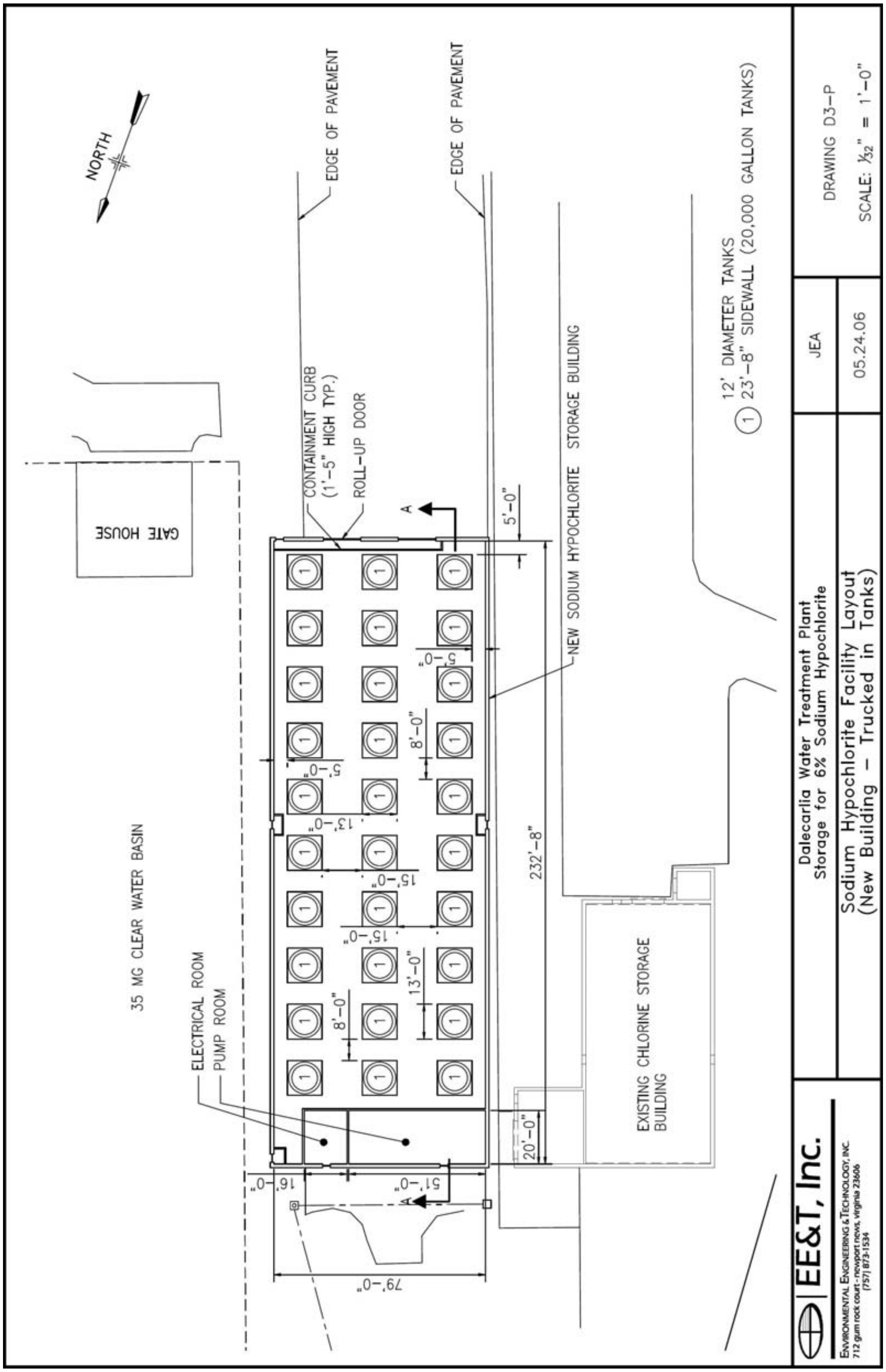
Drawing D2-P: Plan view, Dalecarlia, 12 percent sodium hypochlorite, 25' dia. tanks



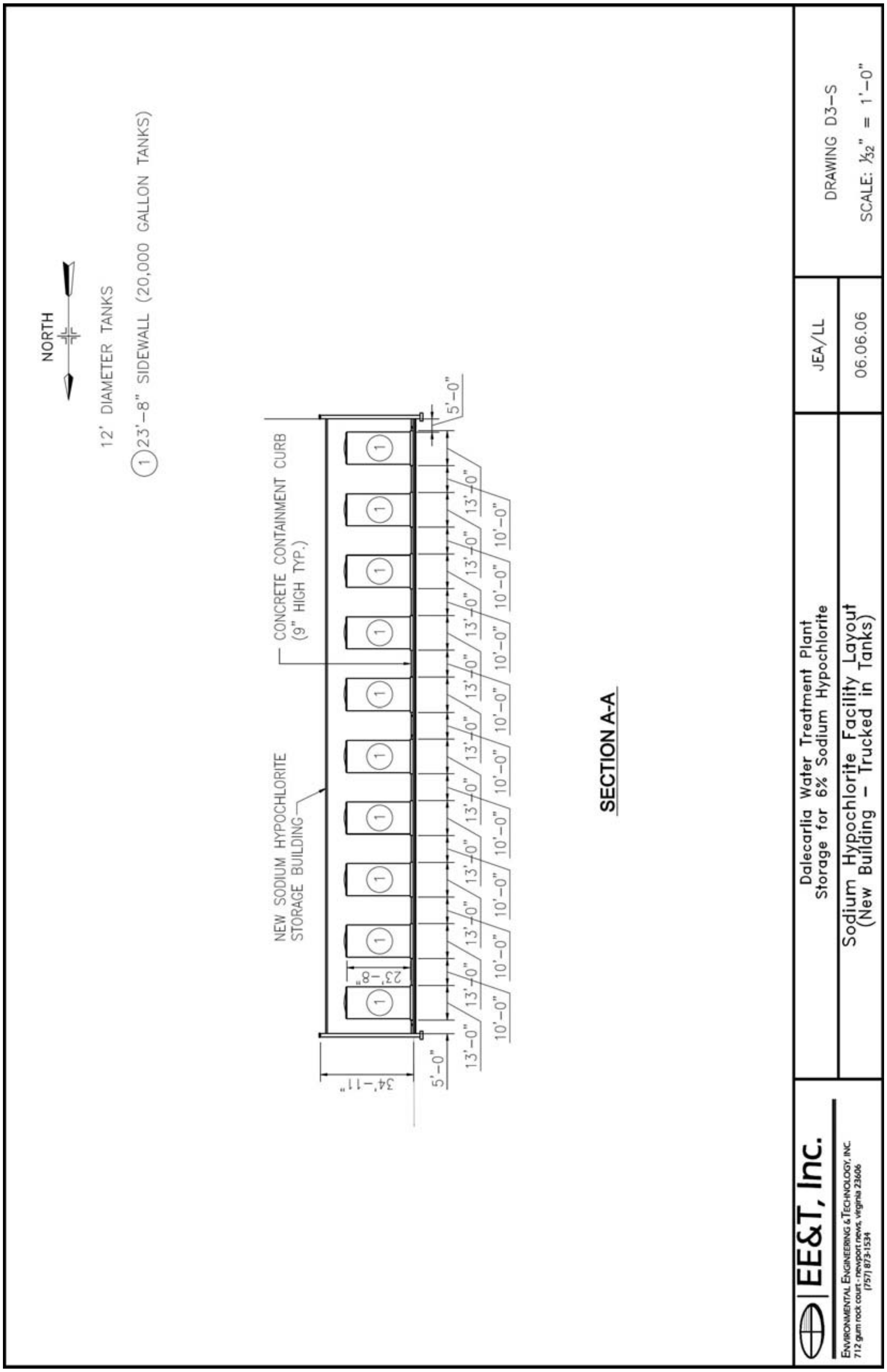
Drawing D2-S: Section, Dalecarlia, 12 percent sodium hypochlorite, 25’ dia. tanks



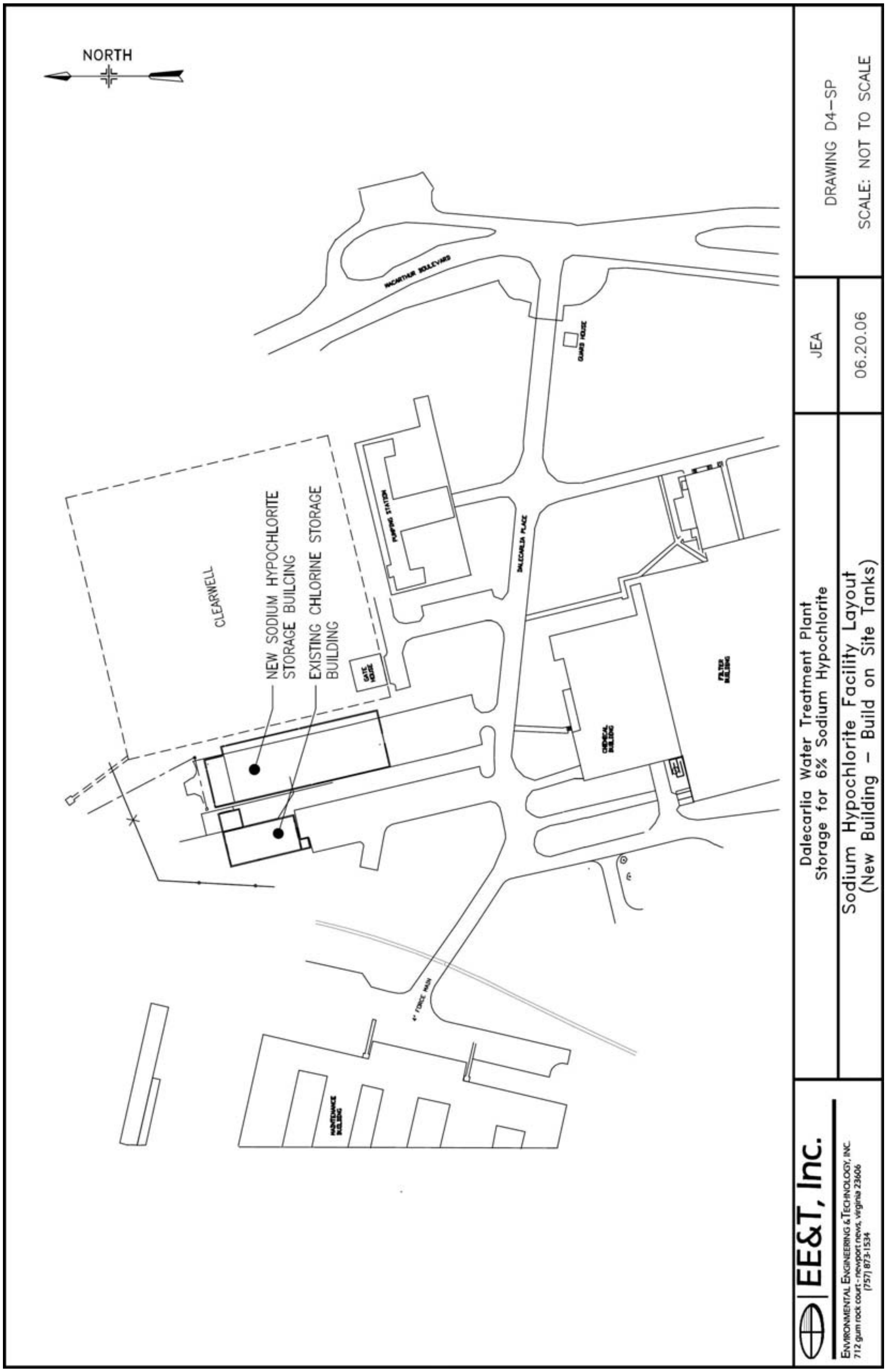
Drawing D3-SP: Site plan, Dalecarlia, 6 percent sodium hypochlorite, 12’ dia. tanks



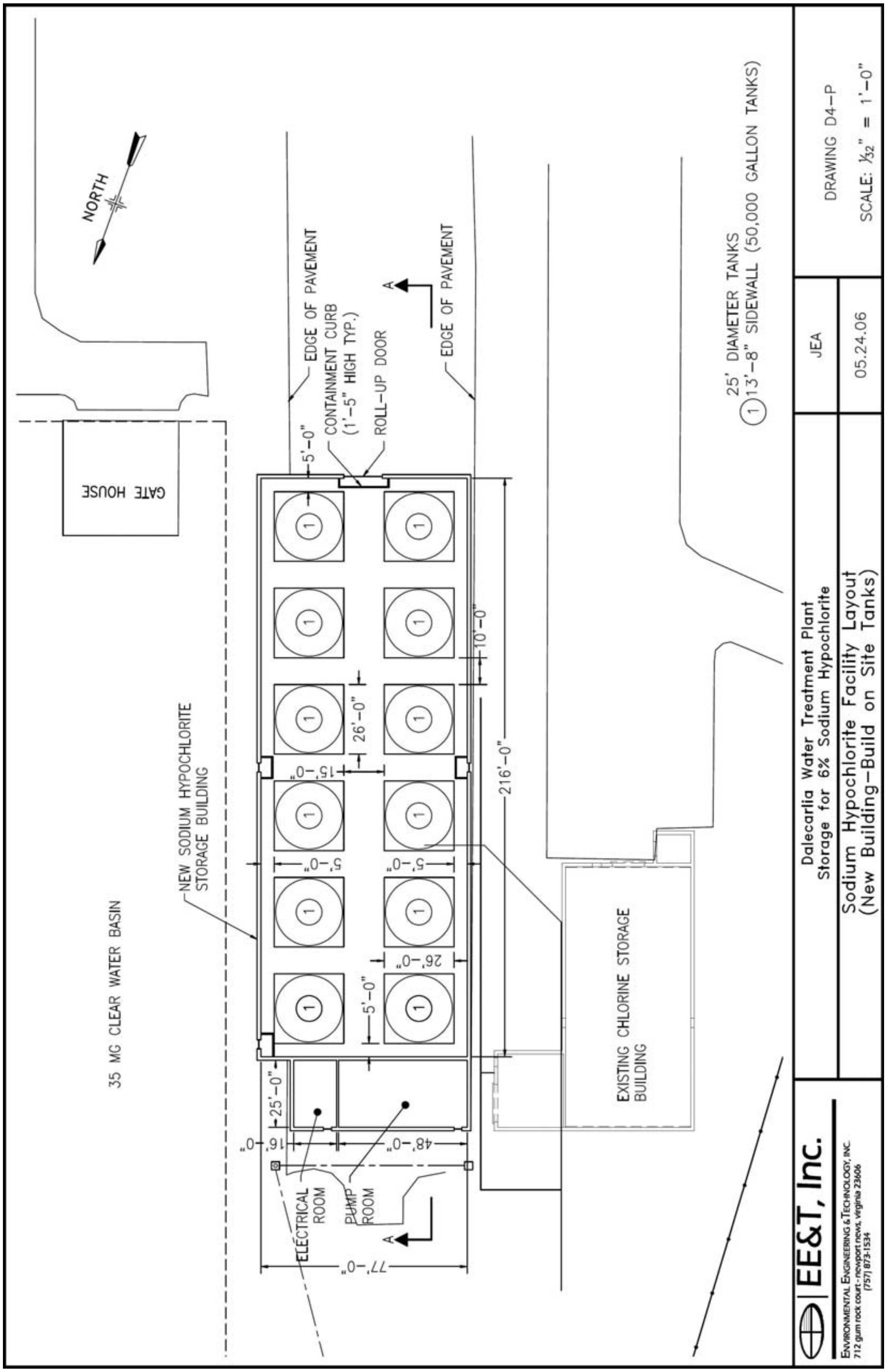
Drawing D3-P: Plan View, Dalecarlia, 6 percent sodium hypochlorite, 12' dia. tanks



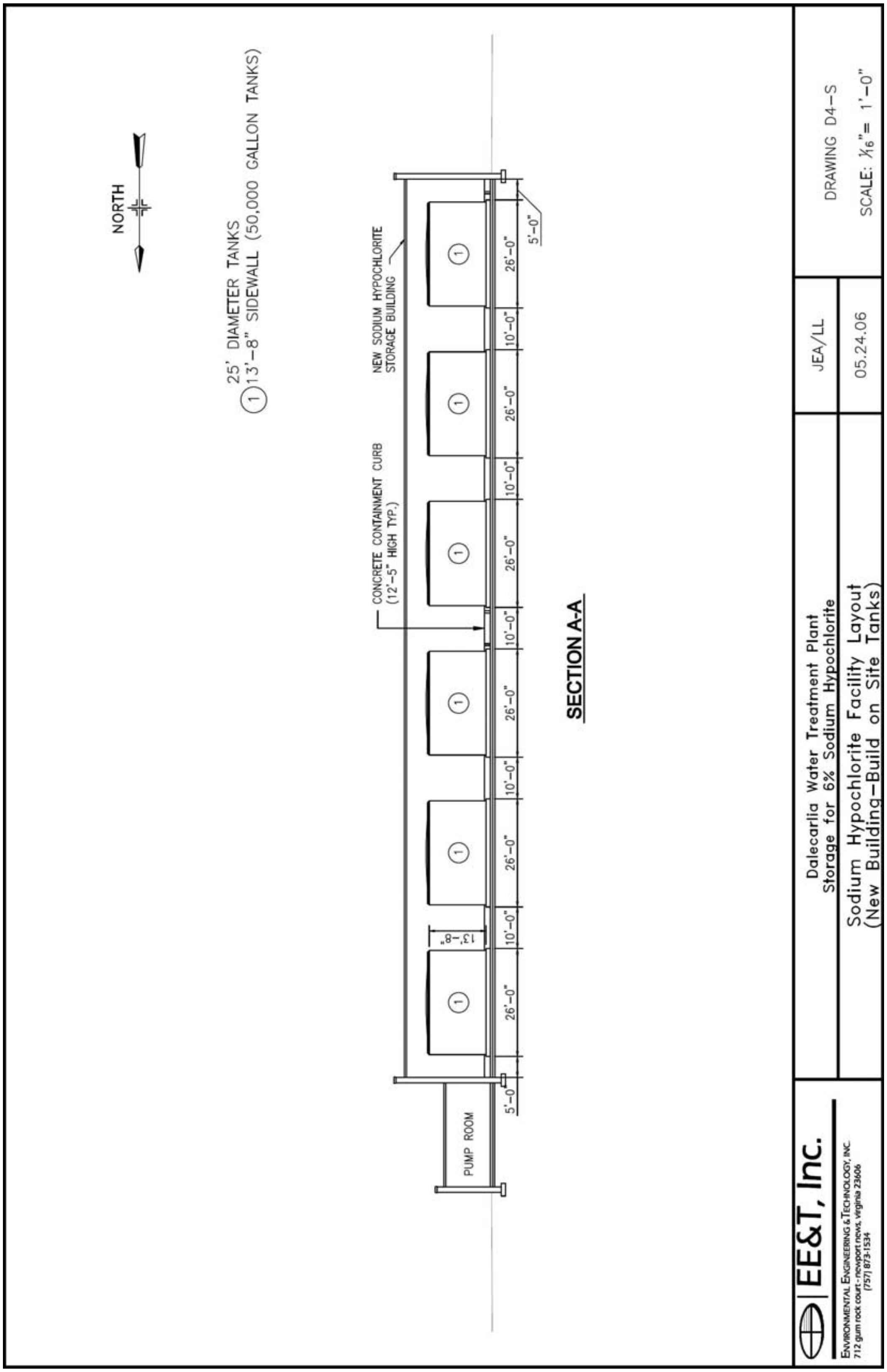
Drawing D3-S: Section, Dalecarlia, 6 percent sodium hypochlorite, 12' dia. tanks



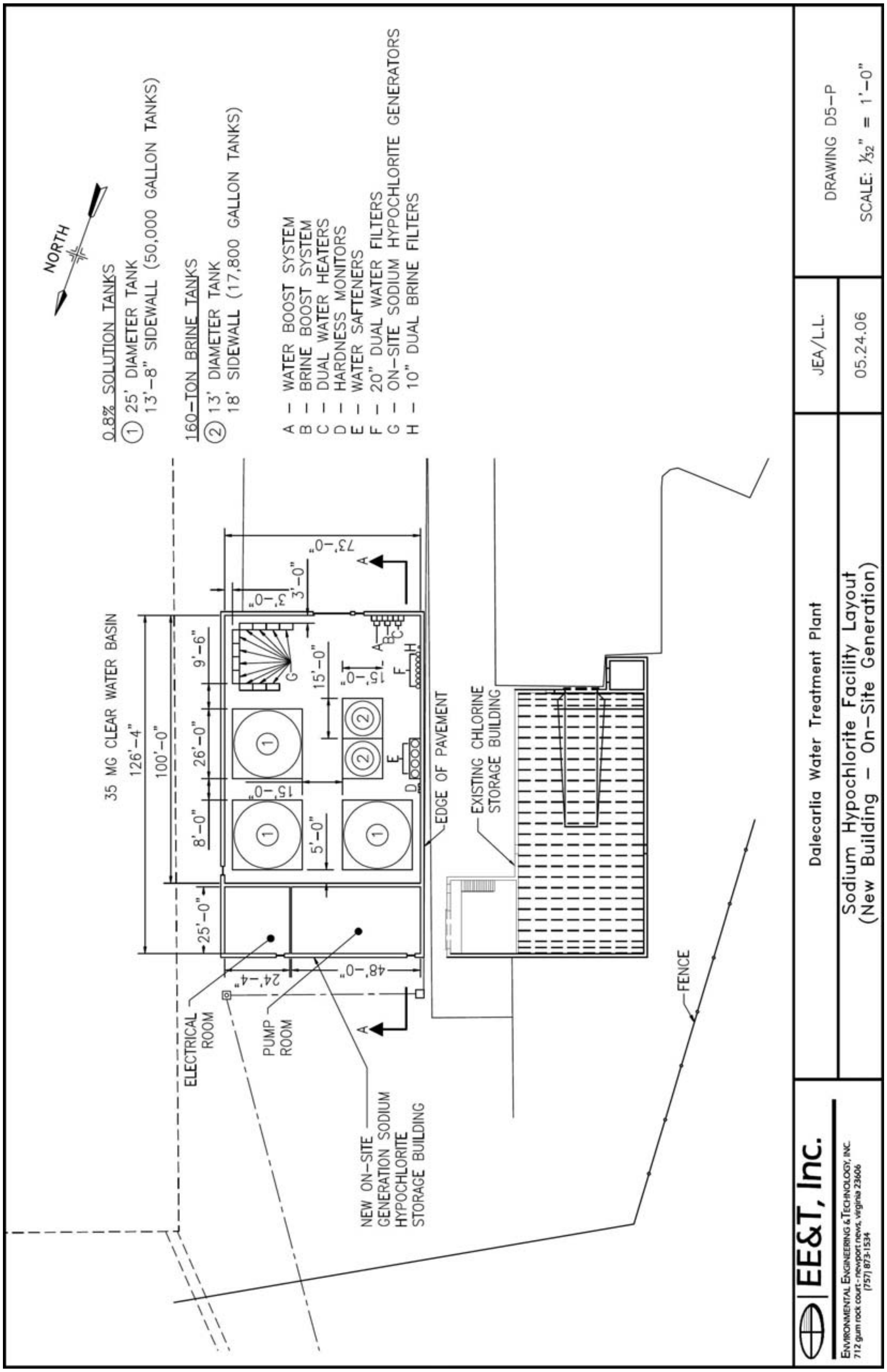
Drawing D4-SP: Site plan, Dalecarlia, 6 percent sodium hypochlorite, 25' dia. tanks



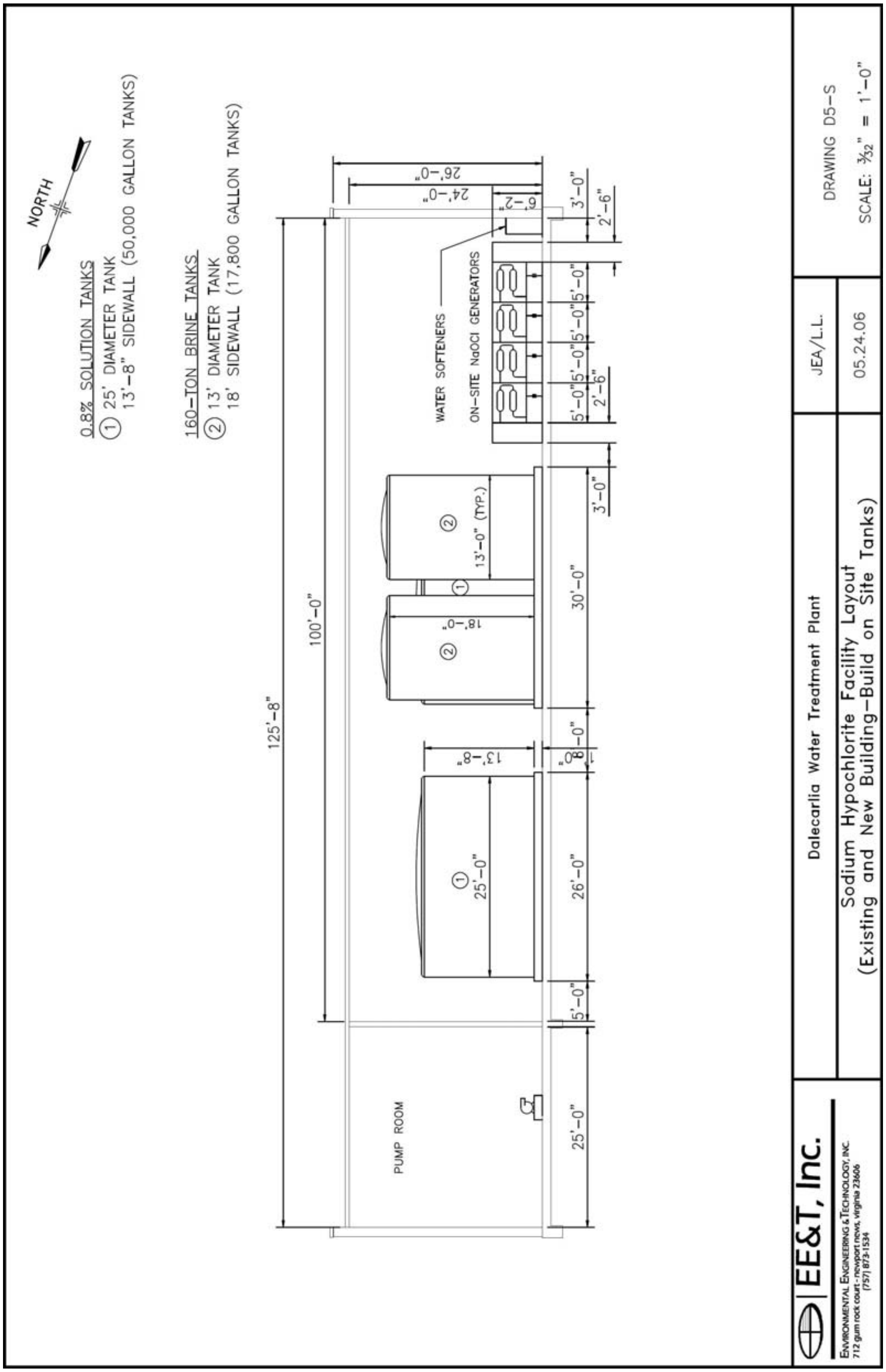
Drawing D4-P: Plan view, Dalecarlia, 6 percent sodium hypochlorite, 25' dia. tanks



Drawing D4-S: Section, Dalecarlia, 6 percent sodium hypochlorite, 25' dia. tanks



Drawing D5-P: Plan view, Dalecarlia, on-site generation of sodium hypochlorite



Drawing D5-S: Section, Dalecarlia, on-site generation of sodium hypochlorite

CHAPTER 3
pH CONTROL CHEMICALS

The proposed change from chlorine gas to sodium hypochlorite disinfection will affect the pH control strategy for both the Dalecarlia and McMillan plants. Both chlorine gas and sodium hypochlorite achieve disinfection by reacting with water to form hypochlorus acid (HOCl). However, the by-products of these reactions are significantly different. Equations 3.1 and 3.2 summarize the reaction of chlorine gas and sodium hypochlorite with water:

$$Cl_2 + H_2O \rightarrow HOCl + HCl \tag{3.1}$$

$$NaOCl + H_2O \rightarrow HOCl + Na^+ + OH^- \tag{3.2}$$

As Equations 3.1 and 3.2 shows, chlorine gas will add hydrochloric acid, while sodium hypochlorite adds hydroxide. Thus, while disinfection currently lowers the pH at both Dalecarlia and McMillan, following the switch to hypochlorite disinfection will raise the pH. .

The Washington Aqueduct has been directed by the United States Environmental Protection Agency (EPA), which is responsible for supervision of pubic water systems in the District of Columbia, to maintain an optimal corrosion control target (OCCT) pH of 7.7 ±0.1 under the Lead and Copper Rule (LCR) for public systems. To comply with this OCCT after the switch to sodium hypochlorite the Washington Aqueduct will need to reduce the amount of base added for finished water pH control and, at times, add acid.

Currently, both McMillan and Dalecarlia slake pebble lime on-site for finished water pH adjustment. Due to the difficulty in maintaining a consistent lime product and administering lime at low chemical doses, The Washington Aqueduct is considering relying on lime only for bulk pH adjustment, followed by a caustic soda (sodium hydroxide) trim to the final pH of 7.7.

DETERMINATION OF REQUIRED DOSES

Background

The scope directed EE&T to utilize/evaluate/update the CH2M Hill pH report to estimate the caustic dose. CH2M Hill used the RTW model to predict equilibrium dose requirements, as do many utilities and consultants including EE&T. The RTW model is a spreadsheet application that uses calcium carbonate chemistry to evaluate the corrosion potential of treated waters. However, RTW has limitations in that it works only for one data entry condition. Probably due to this model limitation, CH2M Hill's report evaluated caustic requirements at three discrete data conditions: minimum, average, maximum as shown below in Table 3.1.

Table 3.1

Caustic soda doses for pH trimming from CH2M Hill pH study report

	Dalecarlia (mg/L)	**McMillan** (mg/L)
Average caustic dose	3.3	2.5
Minimum caustic dose	0.75	0.36
Maximum caustic dose	9.0	11.2
	Dalecarlia (mg/L)	**McMillan** (mg/L)
Average lime dose	12.0	10.7
Minimum lime dose	11.7	9.2
Maximum lime dose	35.3	69.5

To select average, minimum, and maximum operating conditions CH2M Hill appears to have used parameters calculated as average independently of one another. Unfortunately, a review of the data base indicated that average, minimum, and maximum parameters don't pair with each other – that is, they do not occur simultaneously. To overcome this problem it was necessary to evaluate equilibrium conditions based on the historical data set of paired data, i.e. actual daily operating records. RTW is not set up to do this analysis which required utilization of RTW concepts in a macro program to handle the large daily data set that was required to be analyzed. A second limitation of the RTW model is that polyaluminum chloride (PACl) is not in the model, therefore, it was necessary to modify RTW to include PACl. Also, the CH2M Hill analysis of caustic trim requirements was done using chlorine gas as the disinfectant, not sodium hypochlorite as the Washington Aqueduct is switching to. Therefore, their results were not useful in this analysis.

While using paired data sets overcomes limitations in the previous study, there are still limitations to this method. These limitations stem from a limit to the data that can be reported for a continuous operation.

For example, for any given day in the historical data, single values are given in the operating records for influent water quality parameters (alkalinity, temperature, lime, etc.) as well as treatment chemical doses (such as alum, chlorine, lime, etc.) The inherent problem is that there is no method to ensure that the average values reported for the parameters and doses match the actual values that represent the water when the final pH was recorded.

The following example demonstrates this problem. Table 3.2 shows the water quality parameters and treatment doses reported for a two-day period in October 2005. Note that the raw water quality parameters are essentially identical for the both days. The treatment chemical doses are also similar, except that the alum dose for the second day is approximately 2/3 that of the previous. However, despite this difference in coagulant dose, the reported applied and finished water pH values for the two days are essentially identical. Entering these water quality data and treatment doses into RTW, on the other hand, predicts very different pH values for the two days. From a chemistry standpoint, considering only alkalinity reactions, it is not possible that both days had the same final pH with those reported chemical doses and demonstrates the inherent problem of matching historical dose data to pH data.

Table 3.2

Selected water quality and treatment dose data from Dalecarlia WTP historical records

Date	Alk. (mg/L as $CaCO_3$)	Temp. (^oC)	Hardness (mg/L as $CaCO_3$)	Raw pH	Alum (mg/L as dry alum)	Lime (mg/L as CaO)	Chlorine (mg/L as Cl_2)	Reported		Predicted	
								Applied pH	Finished pH	Applied pH	Finished pH
10/17/05	115	18.6	152.0	7.94	45.32	16.91	6.72	7.14	7.75	6.96	7.67
10/18/05	114	18.0	152.4	8.02	31.41	15.47	7.26	7.14	7.7	7.14	8.06

The discussion above assumes that the source of errors between the reported and predicted pH values is essentially a reporting issue – that is, it assumes the reported water quality and treatment dose data reported do not accurately represent the conditions under which the pH values were recorded. However, there is another potential source of error when comparing RTW predicted pH values to reported pH values: inaccuracies in the RTW model itself.

The RTW model assumes all chemical reactions proceed fully to equilibrium, which is not often the case under real world conditions such as those at the treatment plants. Also, end products may be different than those assumed in the RTW model. Therefore, it is reasonable to assume there may be differences between the changes in pH predicted by RTW and the actual changes observed in the field.

Concerns regarding these differences between field conditions and the RTW model led to the implementation of field and laboratory testing to evaluate the extent of these differences, and to determine how to address them in the model. By comparing output from the RTW model to data collected under controlled conditions, EE&T was able to evaluate the suitability of using the RTW model for this feasibility study. To obtain pH data under controlled conditions, EE&T conducted a series of bench-scale tests to replicate the plants' water treatment operations. The following section details the procedure and outcome of these tests.

pH Testing

Water samples for pH testing were collected on four dates: September 18, 2006; October 2, 2006; October 11, 2006; and November 6, 2006. The pH testing performed on these samples essentially investigated pH changes in a jar following chemical doses that replicate the plants' water treatment operations. Two coagulants were used in these tests: alum (the coagulant currently used at both plants) and PACl (the use of which is discussed in Chapter 4). The coagulant dose for the jar was the dose used at the plant on the day the samples were collected (when alum was used as the coagulant) or was selected using jar tests (when PACl was used as a coagulant). To determine the optimal dose of PACl for each pH test, jar tests were performed using four PACl doses and analyzed for turbidity, UV_{254}, and dissolved organic carbon (DOC) removal. The PACl dose that provided the greatest disinfection by-product (DBP) precursor removal relative to the size of the dose was selected as the optimum dose for further testing of the pH control strategies.

The chemicals used in the pH testing are listed below in the order they were added to the jars. Other than the PACl, phosphoric acid, and the chemicals used for pH adjustment (sulfuric acid, lime, or caustic soda), the doses used during the pH tests were the same as the actual chemical doses the plant displayed the day the water was collected. The pH was recorded after every chemical addition in order to compare the change in pH to that predicted by the RTW model. The order of the chemicals is shown below:

1. Sulfuric acid (if needed to adjust coagulation pH)
2. Coagulant (PACl or Alum)
3. Pre-Cl_2 (NaOCl)
4. Post-Cl_2 (NaOCl)
5. Phosphoric Acid (H_3PO_4)
6. Hydrofluorosilicic Acid (H_2SiF_6)
7. Ammonia (NH_3)
8. Lime, Caustic Soda, or Sulfuric Acid ($Ca(OH)_2$, NaOH, or H_2SO_4)

For each pH test, chemicals 1 – 7 were added at predetermined doses. Then, the jar was titrated to the final pH of 7.7 using either lime or caustic soda (or sulfuric acid if the pH was above 7.7.) The results of these tests allowed EE&T to predict the doses needed for Dalecarlia and McMillan to achieve their finished water goals after making the operation changes investigated here. In order to avoid atmospheric CO_2 interference, a zero headspace, sealed system was developed. Also, since pH probes can vary by 0.1 to 0.2 pH units, even after calibration the same type probe as is used by the Washington Aqueduct laboratory was used in these tests.

For each coagulation condition investigated for the Dalecarlia WTP, four pH testing runs were performed using the optimal coagulant dose. The four pH testing scenarios are shown in Figure 3.1 below:

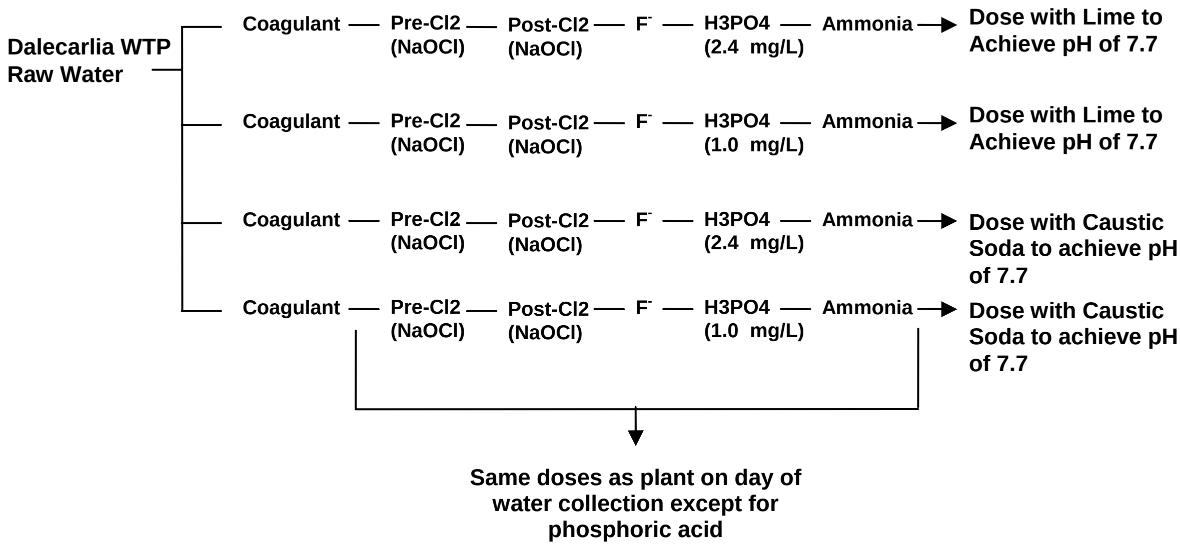


Figure 3.1 pH testing scenarios for Dalecarlia water

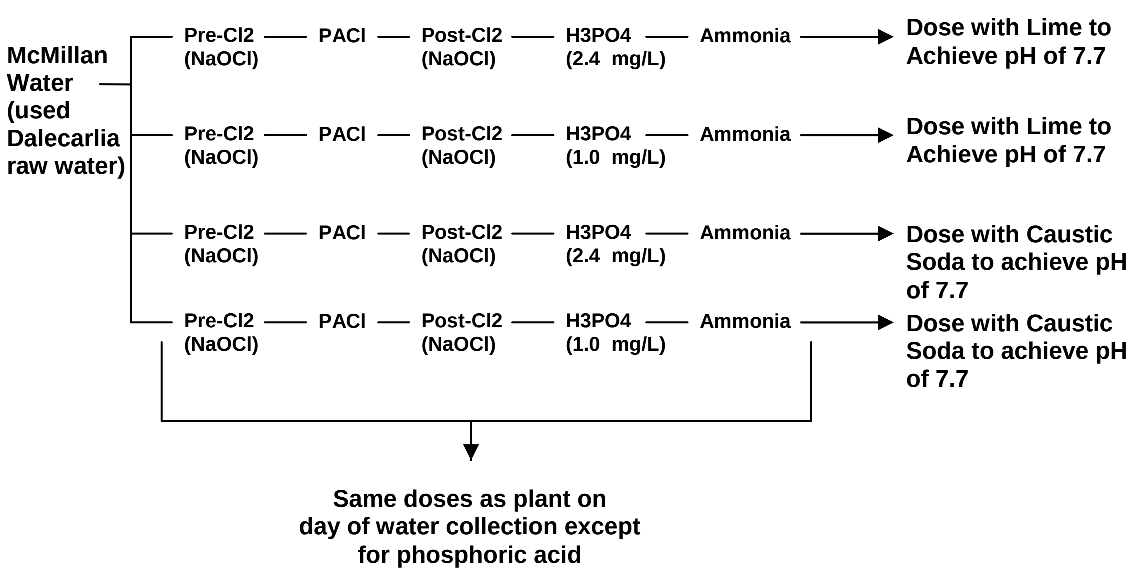


Figure 3.2 pH testing scenarios for McMillan water

Similar testing was conducted using water collected from McMillan WTP. However, because the McMillan water was coagulated prior to reaching the plant, alum coagulation tests were not completed. Figure 3.2 shows the testing scenarios used for McMillan water.

For the Dalecarlia pH tests, five different coagulation conditions were tested. One condition used alum at the same dose used at the plant on the day the water was collected. The other four conditions used PACl for coagulation. There were four different coagulation pH values used when PACl was the coagulant. The four pH values are described below:

1. **Target pH** - Discussions with the Washington Suburban Sanitary Commission (WSSC) indicated that the WSSC has found that a pH between 6.3-6.5 is optimal for DBP precursor removal at their Potomac River plant. Based on these discussions and EE&T's previous recommendations for the optimal total organic carbon (TOC) removal pH , jar tests were conducted using a coagulation pH of 6.5. Jar tests performed at this pH value were identified as "Target pH" jar tests.
2. **Alum pH** - Jar tests were conducted at the coagulation pH that was recorded at the Dalecarlia WTP on the day the raw water samples were collected. The pH values of coagulation ranged near 7.0. Jar tests performed at these pH values were identified as "Alum pH" jar tests.
3. **Float pH** - Jar tests were also conducted without controlling the coagulation pH. During these tests, the coagulation pH levels were allowed to "float" with only the PACl dose controlling the pH. Jar tests performed at these pH values were identified as "Float pH" jar tests.
4. **7.5 pH** - Following further discussions with the WSSC, EE&T was informed that, after switching from alum to PACl, the WSSC found depressing the raw water pH to 7.5 prior to coagulation addition minimized aluminum residuals throughout the plant. Based on this information, one series of jar tests were performed at a coagulation pH of 7.5. These jar tests were identified as "7.5 pH" jar tests.

Due to problems with the method used for the first round of testing, experimental data from the tests using water collected on September 18, 2006 were determined to be in error and are not included in this study. These problems were resolved before the second round of testing.

Therefore, the first round of tests with reliable results was Round 2, which used water collected on October 2, 2006.

Figure 3.3 is an example of a pH test conducted during Round 2 that simulated the effects of coagulating with PACl at a coagulation pH near 6.9. This figure is typical of the results obtained during the pH testing and illustrates several of the trends observed. In general, RTW predicted a greater change in pH than was observed during the pH testing. For example, for a given coagulant dosage (or coagulant and acid dosage if the pH of coagulation was controlled), RTW generally tended to predict a lower pH value than was measured in the lab. Similarly, RTW generally predicted a larger change in pH than was observed following the sodium hypochlorite, phosphoric acid, and hydrofluorosilic acid additions. Also, because ammonium hydroxide does not add or subtract alkalinity from the water, RTW is not able to account for the pH change associated with the ammonia addition.

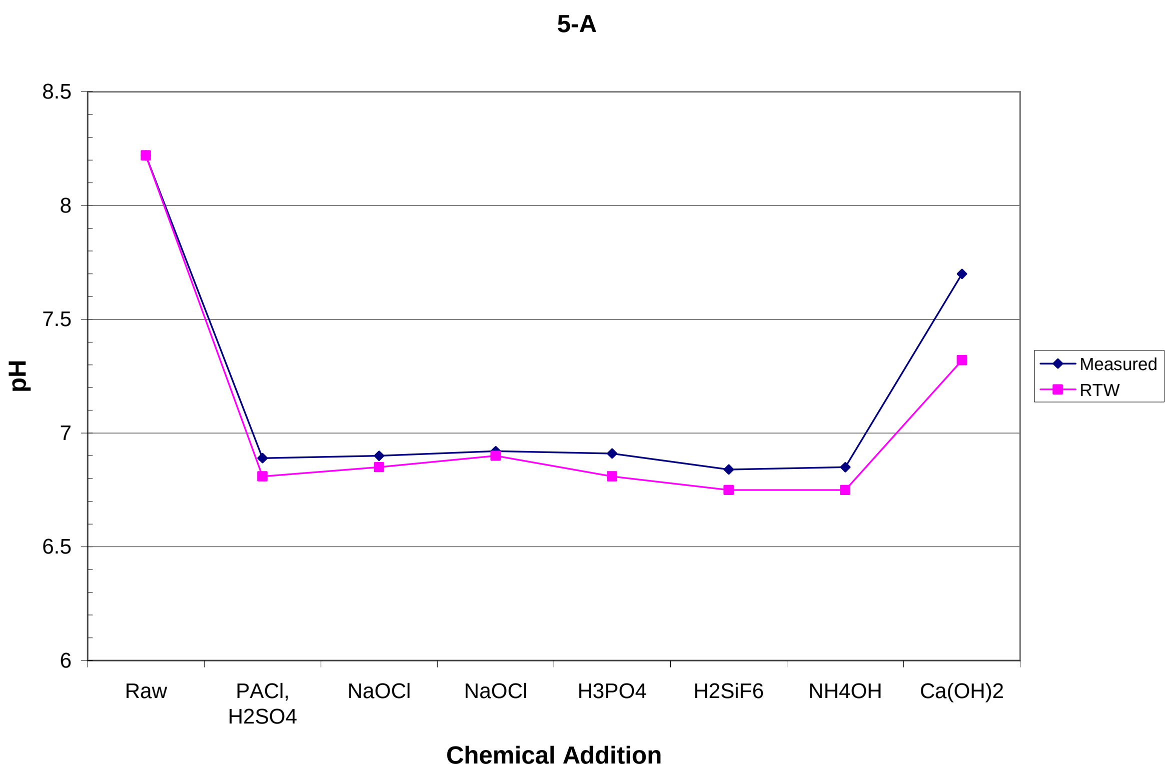


Figure 3.3 Comparison of measured results vs. RTW predictions from Round 2 test 5-A

The result of these differences between RTW and the measured pH values in the lab generally tended to be that RTW predicted a lower pH in the jar prior to the lime or caustic soda addition than was observed. Therefore, RTW generally predicted that more lime or caustic soda would be needed to increase the pH to 7.7 than the lab titration indicated was actually required.

This difference between predicted lime or caustic soda dosage and actual dosage was exacerbated by the higher buffer intensity at lower pH values. This can best be illustrated by examples, as shown by pH testing run 5-A shown in Figure 3.3 above.

During this run, it was found that following all chemical additions other than the lime, the pH of the system was 6.85. It was observed that 14.3 mg/L of slaked lime were required to raise the pH of the system to 7.7. Conversely, RTW predicted a system pH of 6.75 following all chemical additions other than lime. From this pH, 14.3 mg/L of slaked lime would only raise the system pH to 7.32. To achieve a final pH of 7.7, RTW predicted that 18.4 mg/L of slaked lime would be required.

However, of this 18.4 mg/L, it was found that 3.5 mg/L were required to raise the pH from 6.75 to 6.85. The remaining 14.9 mg/L needed to raise the pH from 6.85 to 7.7, is only 4 percent greater than the lime requirement found by the lab titration. This trend was found to be true for all pH tests – assuming RTW started from the pH measured in the lab prior to lime or caustic soda addition, the lime or caustic soda dose predicted by RTW generally matched that found in the lab titration. This indicated that RTW could be used to predict reasonable doses provided the pH used by RTW matched that in the field prior to the lime or caustic soda addition. To accomplish this, pH corrections were performed inside the RTW macro model to account for the difference between the pH predicted by RTW and the pH measured in the lab prior to the lime or caustic soda addition. An example of the effect of this correction for pH test 5-A is shown in Figure 3.4.

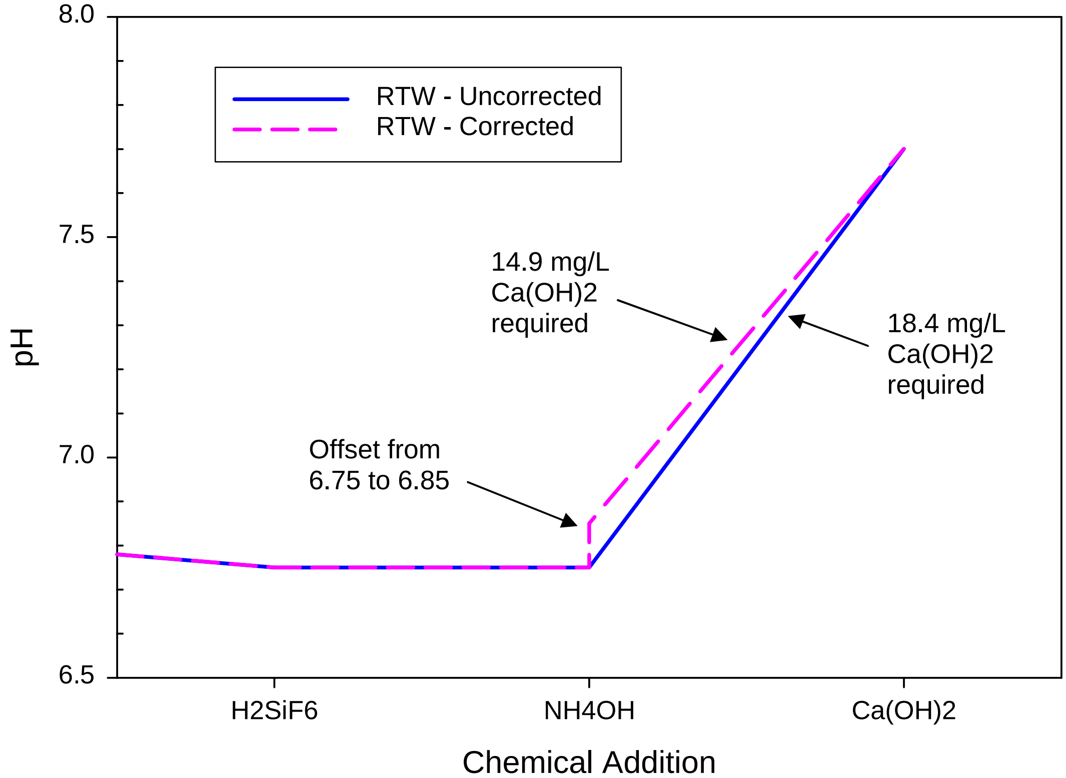


Figure 3.4 Effect of adjusting pH within RTW on predicted lime dose for pH test 5-A

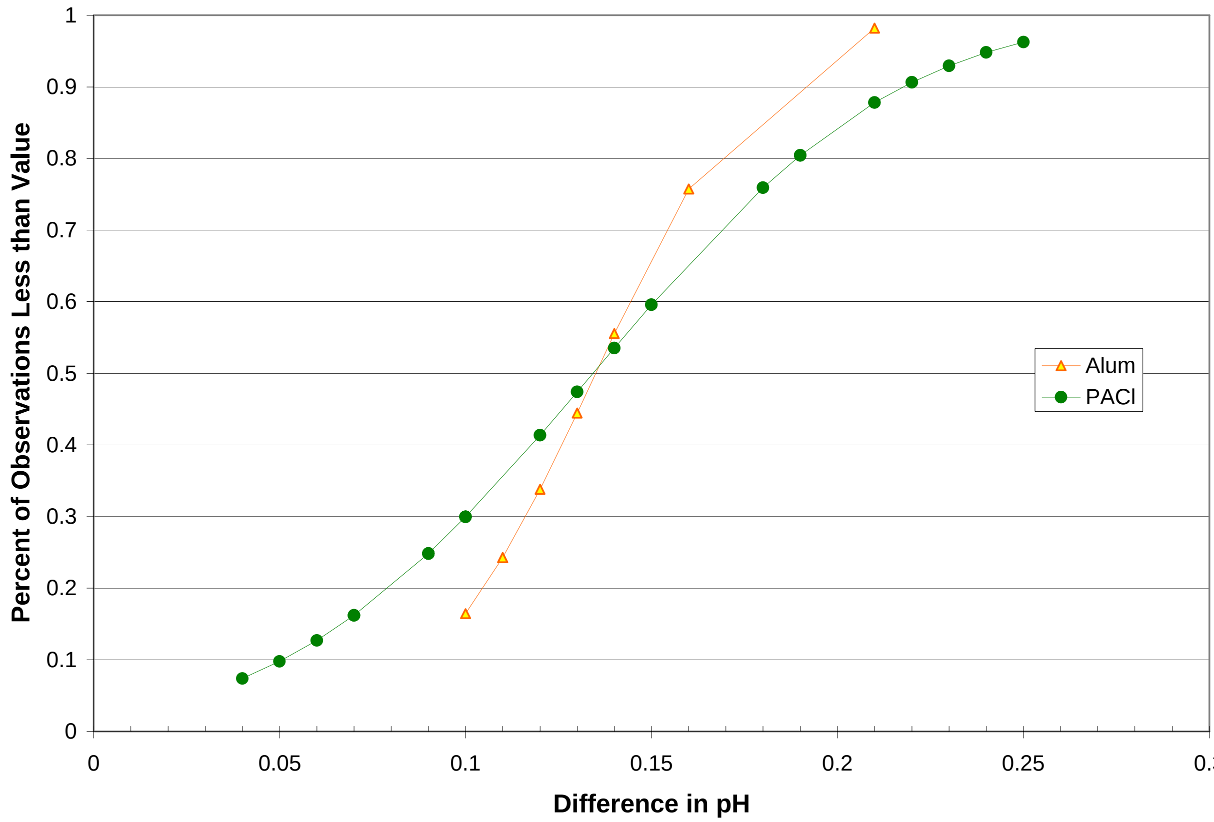


Figure 3.5 Cumulative distribution of difference in pH between RTW model and pH test measurements following all chemical additions other than lime or caustic soda

To determine the correct adjustment factor to use in the RTW model when modeling historical data, the difference between the pH predicted by RTW and the pH measured in the lab prior to lime or caustic acid addition was calculated for all of the pH tests that were conducted. This difference corresponds to the difference between the "Measured" curve and the "RTW" curve following NH_4OH addition in Figure 3.3. Cumulative distributions were then generated, which are shown in Figure 3.5.

When either alum or PACl was used as a coagulant, the average difference in pH prior to lime or caustic soda addition was approximately 0.135. It was determined that this average could be used in RTW as an adjustment factor to better estimate the dose of lime or caustic soda needed to achieve a final pH of 7.7. To implement this in the model, EE&T used RTW to estimate the pH following all chemical additions other than the lime for each historical record. Then, the adjustment factor of 0.135 was added to this pH. RTW was then run using the new pH to determine what lime or caustic soda dose was needed for a pH of 7.7. Note that this corrects for the effect of ammonia addition on pH because the difference in pH due to ammonia addition is included in the values shown in Figure 3.5. This enables the elimination of the 0.1 pH adjustment factor that had been used in previous modeling attempts to account for ammonia.

The above method was used to determine a best estimate of doses needed. However, because there was a distribution of differences between RTW and the bench-scale pH tests, further analysis was conducted to determine the high and low ends of the range of doses that might be expected.

It was determined that using RTW without a correction factor would produce the highest, most conservative, lime or caustic soda dose estimates. To estimate what the lowest lime or caustic soda doses required to adjust to 7.7 might be EE&T selected the 97.7 percent values from Figure 3.5. These values correspond to two-standard deviations above the mean value, and are 0.207 and 0.264 for alum and PACl, respectively.

In some instances it was found that the pH prior to lime or caustic addition was greater than 7.7 when the correction factor was used. In these cases, additional model runs were conducted to determine the amount of sulfuric acid that would needed to lower the finished pH to 7.7. In this case, the estimates are reversed; the highest, most conservative sulfuric acid dose estimates were obtained using the corrected RTW model, while using RTW without the correction factor produced the lowest estimates for sulfuric acid requirements.

An additional correction factor was required when evaluating dose requirements for the McMillan WTP. The influent pH values reported to EE&T for McMillan in the historical records were obtained from the East Shaft sample location. However, the East Shaft is on the opposite side of the McMillan Reservoir than the plant intake. Therefore, it was necessary to add a correction factor to the model to account for pH changes that occur within McMillan Reservoir. During the field pH sampling that was conducted, the largest observed increase in pH between the McMillan Reservoir influent and effluent was approximately 0.3. Additionally, on one day that the field sampling was conducted there was no measurable difference in pH between the McMillan reservoir influent and effluent. Therefore, for each condition evaluated for the McMillan WTP two modeling runs were conducted: one using a correction factor of 0.3 to increase the initial pH and one without a correction factor. The resulting dose calculations for both Dalecarlia and McMillan are shown in Table 3.4 through 3.6

Dose Calculation

With the adjustments outlined above, median and maximum doses for lime, caustic soda, and acid were determined for the scenarios described in Table 3.3. In addition to the predicted median and maximum doses, low and high estimates for the median and maximum doses were determined, as discussed above. These represent the extremes from the bench-scale testing. Note that the scenarios using PACl for coagulation assume that the raw water pH will be adjusted to 7.5 with sulfuric acid prior to coagulation. This assumption stems from discussions with Fairfax County and the Washington Suburban Sanitary Commission, who found that implementing this pH control prior to coagulation reduces aluminum residuals throughout the plant and in the finished water. This is also in line with EE&T's previous recommendation to the Washington Aqueduct that the optimal solubility point for PACl is around 7.6. The estimated average dose of sulfuric acid required for this pH control is 3.9 to 4.0 mg/L as H_2SO_4 with an estimated maximum required dose of 6.5 to 6.6 mg/L as H_2SO_4. These dose estimates are based off of the historic records for raw water pH at the Dalecarlia plant. No adjustment factor was necessary because the bench tests found that RTW accurately modeled the effect of sulfuric acid on raw water pH.

Table 3.3

Scenarios for average and maximum dose determination

Scenario	Raw water pH adjustment	Coagulant	Lime pH adjustment	Caustic pH adjustment
A	N/A	Alum	to 7.4	to 7.7
B	N/A	Alum	-	to 7.7
C	to 7.5	PACl	to 7.4	to 7.7
D	to 7.5	PACl	-	to 7.7

Table 3.4

Estimated chemical doses for pH trimming at Dalecarlia WTP

	Median lime dose (mg/L)			**Maximum lime dose (mg/L)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	1.8	**2.9**	5.8	7.0	**8.7**	13.1
B	N/A	**N/A**	N/A	N/A	**N/A**	N/A
C	0.0	**0.0**	1.3	0.1	**1.2**	3.0
D	N/A	**N/A**	N/A	N/A	**N/A**	N/A

	Median caustic soda dose (mg/L)			**Maximum caustic soda dose (mg/L)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	2.6	**2.7**	2.9	3.3	**3.4**	3.6
B	4.7	**5.9**	9.2	9.4	**11.4**	16.3
C	1.1	**2.3**	2.9	1.7	**2.8**	3.6
D	1.1	**2.5**	4.5	1.9	**3.4**	5.5

	Median acid dose for finished water pH adjustment* (mg/L)			**Maximum acid dose for finished water pH adjustment* (mg/L)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0.0	**0.0**	0.9	0.0	**0.0**	0.0
B	0.0	**0.0**	0.9	0.0	**0.0**	0.0
C	0.0	**0.0**	0.8	0.0	**0.0**	0.0
D	0.0	**0.0**	0.8	0.0	**0.0**	0.0

*Additional sulfuric acid is required for raw water pH adjustment for Scenarios C and D

Table 3.5

Estimated chemical doses for pH trimming at McMillan WTP with pH change in McMillan Reservoir

	Median lime dose (mg/L)			Maximum lime dose (mg/L)		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0.0	**0.0**	0.0	0.0	**0.0**	1.1
B	N/A	**N/A**	N/A	N/A	**N/A**	N/A
C	0.0	**0.0**	0.0	0.0	**0.0**	0.2
D	N/A	**N/A**	N/A	N/A	**N/A**	N/A

	Median caustic soda dose (mg/L)			Maximum caustic soda dose (mg/L)		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0.0	**0.0**	0.7	1.3	**2.0**	2.9
B	0.0	**0.0**	0.7	1.3	**2.0**	3.8
C	0.0	**0.1**	1.3	0.3	**1.1**	2.0
D	0.0	**0.1**	1.3	0.3	**1.1**	2.2

	Median acid dose for finished water pH adjustment* (mg/L)			Maximum acid dose for finished water pH adjustment* (mg/L)		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0.0	**0.4**	0.9	1.0	**2.0**	2.5
B	0.0	**0.4**	0.9	1.0	**2.0**	2.5
C	0.0	**0.0**	0.8	0.0	**0.5**	1.5
D	0.0	**0.0**	0.8	0.0	**0.5**	1.5

*Additional sulfuric acid is required for raw water pH adjustment for Scenarios C and D

Table 3.6

Estimated chemical doses for pH trimming at McMillan WTP without pH change in McMillan Reservoir

	Median lime dose (mg/L)			**Maximum lime dose (mg/L)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0.0	**0.0**	1.0	2.1	**3.3**	6.5
B	N/A	**N/A**	N/A	N/A	**N/A**	N/A
C	0.0	**0.0**	1.9	0.3	**1.6**	3.6
D	N/A	**N/A**	N/A	N/A	**N/A**	N/A

	Median caustic soda dose (mg/L)			**Maximum caustic soda dose (mg/L)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	1.4	**2.0**	2.8	3.3	**3.5**	3.9
B	1.4	**2.2**	4.2	5.2	**6.6**	9.9
C	1.4	**2.6**	2.9	2.0	**3.2**	3.6
D	1.4	**2.9**	5.1	2.4	**3.9**	6.3

	Median acid dose for finished water pH adjustment* (mg/L)			**Maximum acid dose for finished water pH adjustment* (mg/L)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0.0	**0.0**	0.0	0.0	**0.0**	0.3
B	0.0	**0.0**	0.0	0.0	**0.0**	0.3
C	0.0	**0.0**	0.0	0.0	**0.0**	0.0
D	0.0	**0.0**	0.0	0.0	**0.0**	0.0

*Additional sulfuric acid is required for raw water pH adjustment for Scenarios C and D

Estimated storage volumes to provide 30 days storage for the caustic soda and acid doses required are shown in Tables 3.7 and 3.8. These estimates were created assuming caustic soda would be stored at 25 percent strength, while sulfuric acid would be stored at 93 percent. The flow rates for storage estimates are 132 mgd and 74 mgd at Dalecarlia and McMillan, respectively. Please note that Table 3.7 only includes the acid required for *finished* water pH control. The sulfuric acid requirements for raw water pH control when PACl is used for coagulation are discussed in detail in Chapter 4.

Table 3.7

Estimated caustic soda storage volumes (25 percent concentration) for finished water pH adjustment

Dalecarlia WTP

	30 day storage @ median caustic soda dose (gallons)			30 day storage @ maximum caustic soda dose (gallons)		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	32,100	**33,400**	35,900	40,800	**42,000**	44,500
B	58,100	**73,000**	113,800	116,200	**141,000**	201,500
C	13,600	**28,400**	35,900	21,000	**34,600**	44,500
D	13,600	**30,900**	55,600	23,500	**42,000**	68,000

McMillan WTP with pH change in McMillan Reservoir

	30 day storage @ median caustic soda dose (gallons)			30 day storage @ maximum caustic soda dose (gallons)		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0	**0**	4,900	9,000	**13,900**	20,100
B	0	**0**	4,900	9,000	**13,900**	26,300
C	0	**700**	9,000	2,100	**7,600**	13,900
D	0	**700**	9,000	2,100	**7,600**	15,200

McMillan WTP without pH change in McMillan Reservoir

	30 day storage @ median caustic soda dose (gallons)			30 day storage @ maximum caustic soda dose (gallons)		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	9,700	13,900	19,400	22,900	**24,300**	27,000
B	9,700	15,200	29,100	36,000	**45,700**	68,600
C	9,700	18,000	13,200	13,200	**22,200**	25,000
D	9,700	20,100	35,400	35,400	**27,000**	43,700

Table 3.8

Estimated sulfuric acid storage volumes (93 percent concentration) for finished water pH adjustment*

Dalecarlia WTP

	30 day storage @ median sulfuric acid dose (gallons)			**30 day storage @ maximum sulfuric acid dose (gallons)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0	**0**	0	0	**0**	0
B	0	**0**	0	0	**0**	0
C	0	**0**	0	0	**0**	0
D	0	**0**	0	0	**0**	0

McMillan WTP with pH change in McMillan Reservoir

	30 day storage @ median sulfuric acid dose (gallons)			**30 day storage @ maximum sulfuric acid dose (gallons)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0	**500**	1,200	1,300	**2,600**	3,200
B	0	**500**	1,200	1,300	**2,600**	3,200
C	0	**0**	1,000	0	**0**	1,900
D	0	**0**	1,000	0	**0**	1,900

McMillan WTP without pH change in McMillan Reservoir

	30 day storage @ median sulfuric acid dose (gallons)			**30 day storage @ maximum sulfuric acid dose (gallons)**		
Scenario	Low	**Predicted**	High	Low	**Predicted**	High
A	0	0	0	0	**0**	400
B	0	0	0	0	**0**	400
C	0	0	0	0	**0**	0
D	0	0	0	0	**0**	0

*Additional sulfuric acid is required for raw water pH adjustment for Scenarios C and D

For both Dalecarlia and McMillan, the required lime doses following the switch to hypochlorite will be much lower than the doses currently administered at either plant. For McMillan, it appears that there is little advantage to using slaked lime for bulk pH control with a caustic soda trim to reach the final pH target of 7.7. By the time the water reaches the plant the pH is near if not above 7.4, so little to no lime would be required. The highest estimated average day lime dose for any condition at McMillan is 1.9 mg/L as $Ca(OH)_2$. It is recommended that only caustic soda be used for pH control at the McMillan WTP.

Slightly higher doses of lime would be required at the Dalecarlia WTP for bulk pH control, but again, the relatively small doses required would be difficult to control with the existing lime slakers. According to the Washington Aqueduct, with the existing lime slakers lime cannot be accurately dosed at a rate less than 200 lb/hr as CaO. At the median flow rate of 99 mgd at Dalecarlia, this is equivalent to a 5.8 mg/L dose as CaO (7.7 mg/L as $Ca(OH)_2$). After switching to hypochlorite, the median lime dose required to raise the pH to 7.4 would range between 1.8 to 5.8 mg/L as $Ca(OH)_2$, below the range of the existing equipment. Therefore, in order to implement lime for bulk pH control, it will be necessary to switch out the existing lime slakers for equipment that can accurately administer lime at low doses. This could possibly be accomplished by switching to a hydrated lime product dosed using volumetric screw feeders. EE&T has not investigated the feasibility of modifying the existing slakers to accurately feed the lower amount of required lime but were asked by the Washington Aqueduct to assume its feasibility.

Operational complexity would be reduced at the Dalecarlia plant if pH control was accomplished using caustic soda only. However, under current conditions of using alum for coagulation, the average caustic soda dose required without lime is significantly higher than for any other scenario. With a median caustic soda dose of 5.9 mg/L as NaOH, the estimated storage volume for 30 days of average dose storage is approximately 2 to 3 times larger than the storage required for the next highest scenario. The approximate higher annual chemical cost for using all caustic compared to using lime plus caustic is $170,000. Therefore, maintaining lime for bulk pH control while alum is used for coagulation at Dalecarlia is more economical, although the lime doses required are still quite low and may be difficult to dose accurately.

One potential complication caused by the switch to hypochlorite is the occasional need for acid addition at the McMillan plant to achieve a finished water pH of 7.7. However, the acid doses that would be required are fairly minimal, with a maximum required dose of less than 2.5 mg/L as H_2SO_4. Of course, this assumes a maximum increase of 0.3 pH across the McMillan Reservoir; if conditions result in a larger pH increase during some parts of the year, the acid requirement will increase accordingly.

Sulfuric Acid for PACl Coagulation

As will be discussed in Chapter 4, it will be necessary to add sulfuric acid to lower the raw water pH prior to coagulation if PACl is utilized for coagulation (Scenarios C and D). Based on discussions with other water agencies that use PACl coagulation and the chemistry of PACl, EE&T recommends that sufficient acid be dosed to the raw water to lower the pH to 7.5 prior to coagulation in order to minimize aluminum residuals in the distribution system. However, the Washington Aqueduct has expressed some interest in lowering the coagulation pH below 7.5 when PACl is used for coagulation. Two potential pH targets are 7.1, which is the current average coagulation pH for alum coagulation, and 6.5, which has been used by some agencies to enhance removal of disinfection by-product precursors. Table 3.9 illustrates the doses and storage volumes of acid that would be required for raw water pH control under these scenarios. Note: RTW accurately predicted pH changes following sulfuric acid addition to raw water, so no correction factor was applied when determining sulfuric acid requirements for raw water pH adjustment

Table 3.9

Sulfuric acid requirements for raw water pH adjustment and base requirements for post-treatment pH adjustment when PACl is used for coagulation*

	Chemical Dose Required	**Pre-Coagulation pH Target**		
		7.5	**7.1**	**6.5**
	Sulfuric Acid to Pre-Coagulation pH Target (mg/L)	3.9	11.4	33.9
Scenario C	Lime Dose to 7.4 (mg/L as $Ca(OH)_2$)	0.00	4.07	16.71
Scenario C	Caustic Soda Dose to 7.7 (mg/L)	2.41	2.73	2.51
Scenario D	Lime Dose to 7.4 (mg/L as $Ca(OH)_2$)	N/A	N/A	N/A
Scenario D	Caustic Soda Dose to 7.7 (mg/L)	2.63	7.03	20.53

*Sufficient for raw flow for both plants. Lime and caustic soda doses shown are weighted averages by flow from both plants. Doses are average based on the three years of historical data that were evaluated.

Clearly, significantly higher doses of sulfuric acid are required (and correspondingly more base would be required) to lower the pre-coagulation raw water pH below 7.5. The benefit, or lack thereof, of using a coagulation pH less than 7.5 for PACl coagulation is discussed in Chapter 4. For the purposes of storage layout and sizing for this feasibility study, it was assumed that for PACl coagulation, the Washington Aqueduct would only add sufficient acid for a coagulation pH of 7.5.

STORAGE AND DELIVERY ISSUES

Caustic Soda and Sulfuric Acid Storage and Layout

Following the analysis above, caustic soda and acid storage volumes were selected for both Dalecarlia and McMillan. For Dalecarlia, a storage volume of 48,000 gallons for 25 percent caustic soda was selected. This provides more than 30 days of storage at maximum flow, maximum dose for the caustic soda trimming scenarios, and still provides approximately 20 days of storage at maximum flow, median dose under worst case conditions assuming the lime feed system is out of service. Unlike sodium hypochlorite, caustic soda does not degrade during storage, so storing caustic soda in excess of the 30-day demand is not a concern. Scrubber facilities are not required for storage of caustic soda.

For McMillan, a storage volume of 24,000 gallons was selected for caustic soda. This provides approximately 16 days storage at maximum flow, maximum dose under worst case conditions (no pH change in the reservoir) and well in excess of 30 days storage at maximum flow, maximum dose under more favorable conditions.

McMillan also requires sulfuric acid for pH control. However, sulfuric acid is stored at a high concentration (93 percent) so less volume is required. A storage volume of 5,000 gallons is recommended. This volume is larger than the required volumes shown in Table 3.8, but provides more flexibility in case pH rises in excess of 0.3 occur in the McMillan reservoir during certain times of the year, and allows for full truck deliveries.

Finally, while sulfuric acid is not required for final pH control at Dalecarlia, the modeling conditions assumed that the raw water pH would be depressed to 7.5 prior to coagulation if PACl is used as a coagulant. Because coagulation for McMillan is controlled at Dalecarlia, sufficient volume must be provided for raw water pH adjustment at both plants. It is recommended that a total sulfuric acid storage volume of 24,000 gallons be constructed at Dalecarlia in the event that PACl coagulation is used. This volume will provide 30 days storage at the combined maximum flow, maximum dose for both plants.

McMillan WTP

Figure 3.7 shows the proposed caustic soda and sulfuric acid storage layout for McMillan, which utilizes the existing chlorine room to store the chemicals. However, because the chlorine room must remain active during construction, temporary chemical storage and feed facilities will be needed for the caustic soda and sulfuric acid during construction. To avoid the need for these temporary facilities, it may be possible to use one of the slow sand filters for caustic soda and sulfuric acid storage. This topic is discussed in greater detail in Chapter 5.

Dalecarlia WTP

The proposed layout for the caustic soda storage tanks (and sulfuric acid storage in the event PACl coagulation is implemented) is shown in Figure 3.8. As this figure shows, the existing chlorine storage building will be converted to the caustic soda (and acid) storage area. Construction sequencing needed to implement this storage scenario will be discussed in Chapter 5.

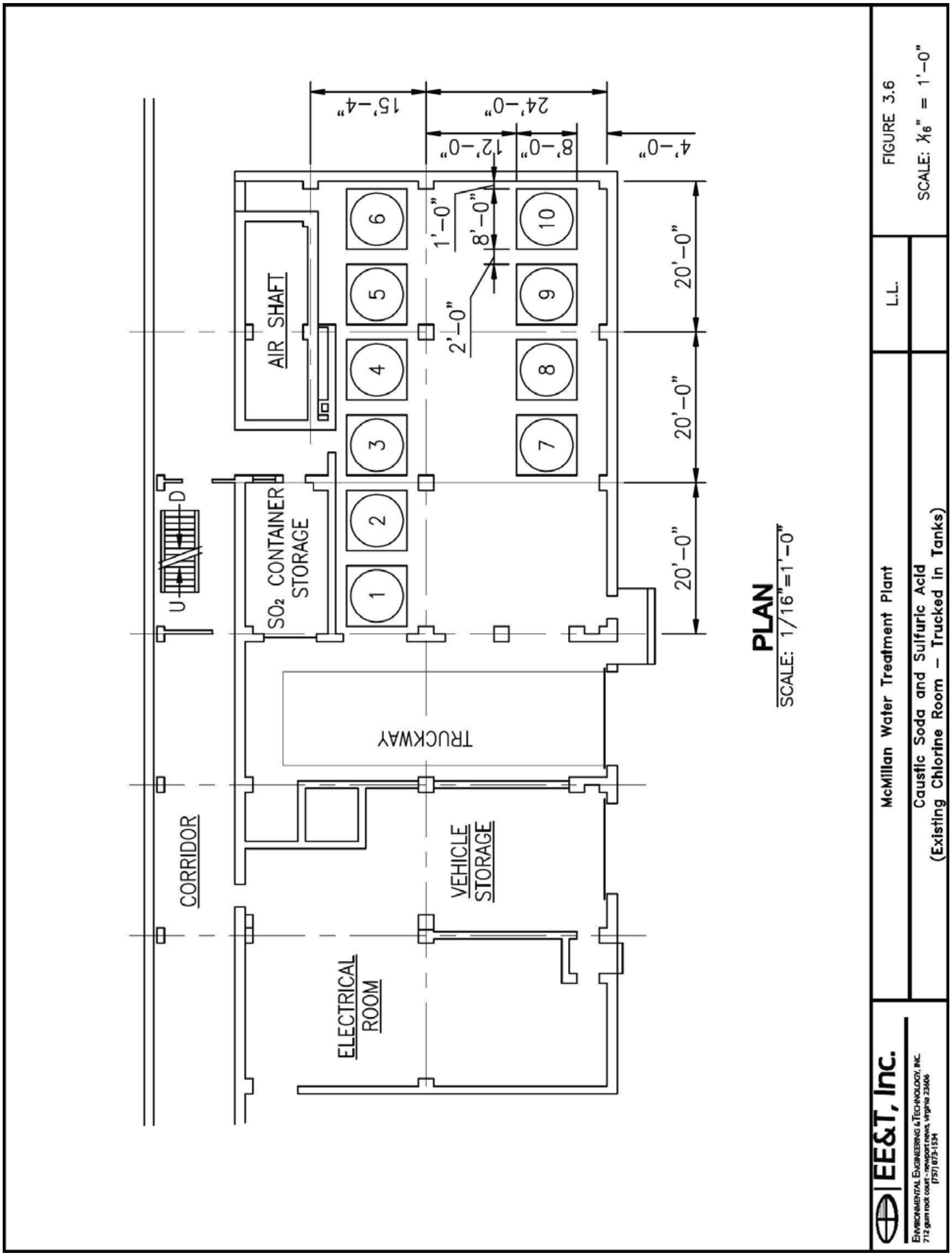


Figure 3.6 Plan view, McMillan WTP, caustic soda and sulfuric acid storage in existing chlorine room

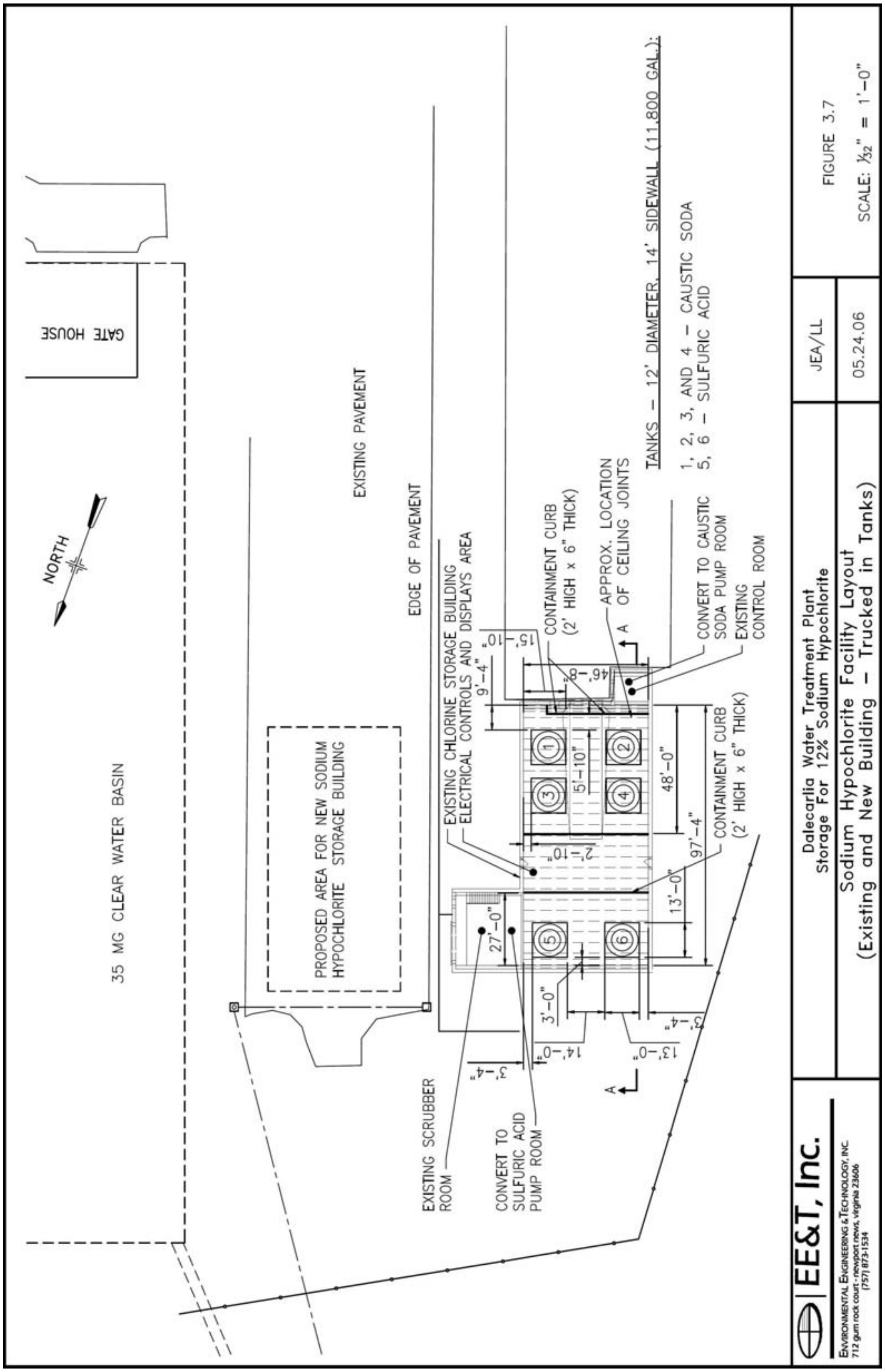


Figure 3.7 Plan view, Dalecarlia WTP, caustic soda and sulfuric acid storage in existing chlorine building

Storage Tank Materials and Method of Construction

Liquid caustic soda (NaOH) is defined as a corrosive product. It is normally stored in steel, nickel, or certain types of plastics. The choice is determined by temperature, concentration, tank location, and safety issues (Solvay Chemicals International, 2006). Listed below are suitable tank material choices for caustic soda.

- Stainless Steel (AISI 304/316/316L) – Suitable for temperatures up to 70^{o}C
- Low Carbon Steel – Unlined soft steel with a corrosion allowance is suitable if the iron content in the end product is not important, and storage temperature is lower than 45^{o}C
- Lined Steel – Lined soft steel with a corrosion allowance is suitable if the iron content in the end is important or the temperature of the liquid is higher than 45^{o}C
- Plastics – Plastic tanks may be used if the supplier specifications are strictly followed. Glass fiber reinforced polyester with a polypropylene lining or a polyvinyl chloride (PVC) lining are suitable to a maximum temperature of 60^{o}C. Condition of the liner should be checked regularly

When stored at a concentration of 50 percent, the viscosity of caustic soda increases rapidly when the temperature falls below 16°C. For this reason, caustic soda stored at 50 percent must be maintained at temperatures above 25°C at all times to prevent slush formation and to protect equipment. Unlike sodium hypochlorite, diluting caustic soda is a highly-complicated process due to the exothermic reaction of caustic soda with water. For these reasons, EE&T recommends the Washington Aqueduct purchase and store 25 percent caustic soda.

Sulfuric acid becomes more corrosive as the acid concentration decreases. For this reason it is recommended to store and feed the acid at the delivered concentration (93 percent). The recommended material for storing sulfuric acid is steel (without galvanization), yet other suitable alloys may be substituted. It is important for the tanks to be vented since considerable amounts of hydrogen gas can develop. Plastic tanks are not recommended because they are more prone to rupturing compared to steel tanks. Scrubber facilities are not required for the storage of sulfuric acid.

Plastic lined steel (polypropylene, PVDC, TFE are suitable liners) or stainless steel piping should be used in the design for piping associated with the sulfuric acid. It is strongly advised that the piping not be buried. If piping is run underground, a concrete trench, PVC conduit, or both is recommended so that all leaks can be detected quickly and easily (General Chemical Corporation, 2006).

Feed Points - Monitoring

Whether caustic is employed to raise the pH from coagulation pH to 7.6 or trim pH from 7.4 to 7.6, and regardless of the coagulant (i.e., Alum or PACl), it will be fed at the same locations within the treatment process as lime feed points. At McMillan WTP the optimal feed point is after the filters and before the first clearwell where lime is currently being fed in a mixing chamber. This will also be the proposed feed point for the sulfuric acid. It is recommended that the pH control system be designed such that caustic soda and sulfuric acid cannot be fed simultaneously to prevent potentially dangerous chemical reactions, and pH searching in the feedback control loop. At Dalecarlia WTP, it is proposed that lime feed point be located prior to the first clearwell, with the caustic soda feed point located between the first and second clearwells. This provides sufficient reaction time for the pH to stabilize following the lime injection prior to the first clearwell.

Feeding lime prior to the first clearwell will raise the pH of chlorine disinfection, which in turn will lower the effectiveness of chlorine disinfection in the clearwells. However, review of the current contact time (CT) data for the first clearwell shows that the CT provided in this clearwell far exceeds EPA requirements. Figure 3.9 summarizes the daily average CT values achieved in the first clearwell from November 2005 to October 2006.

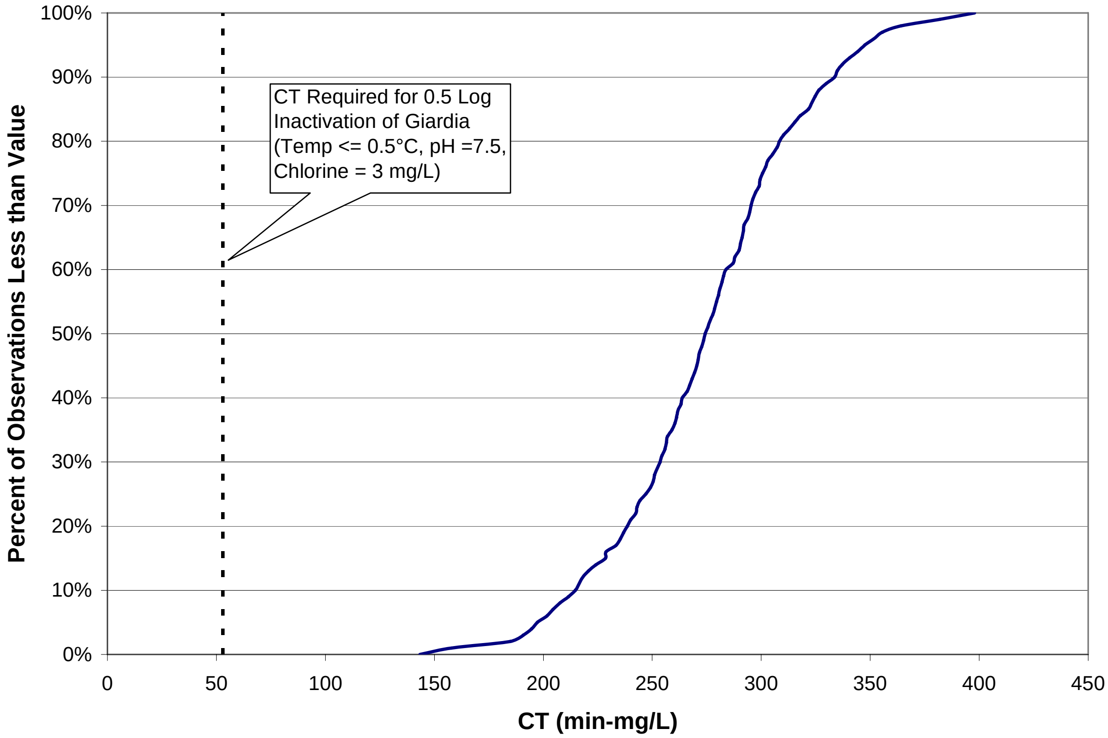


Figure 3.8 Percentile plot of daily average CT values recoded from November 2005 to October 2006 in the 15-MG clearwell at Dalecarlia

For conventional treatment plants, EPA requires that 0.5-log inactivation of Giardia be achieved through disinfection. As Figure 3.8 shows, even at a pH of 7.5 and extremely low temperature (required CT increases as the temperature decreases), the available CT in the first clearwell far exceeds the CT needed for 0.5-log *Giardia* inactivation.

Due to the corrosive nature of both caustic soda and sulfuric acid, it is recommended that both chemicals be fed through lined steel pipe laid in a concrete trench box covered with metal or fiberglass reinforced plastic lids. This allows for easy inspection of the piping, and access in the event of a leak. Insulating the lids of the trench boxes should be sufficient to prevent the chemicals from freezing due to the low freezing points of the caustic soda and sulfuric acid (−19°C and −29°C, respectively). Another alternative would be to heat trace the pipe. Also, it is recommended the acid piping be run through PVC conduit in the trench box. This provides an extra layer of protection, while still providing for visual inspection of the condition of the pipe.

Truck Deliveries

To determine the impact switching to hypochlorite would have on truck deliveries, three scenarios were analyzed. The baseline scenario was calculated using the historical data to determine the average number of truck deliveries of pH control chemicals to each plant using the current operating scheme. Scenarios A and B predict the pH control chemical usage after the switch to hypochlorite and caustic soda. Scenario A assumes that lime would be used for bulk pH control to 7.4, while caustic soda would be used to trim the pH to the target of 7.7. Conversely, Scenario B looks at the truck deliveries that would be required if only caustic soda is used for pH control. Both Scenarios A and B assume that it may be necessary to add sulfuric acid at times at the McMillan plant to achieve the finished water pH target of 7.7. Unlike the analysis to determine required storage volumes, this analysis considered the trucks needed monthly assuming average dose, average flow at each plants. The plant flows used were the same as those used to determine hypochlorite deliveries: 99 mgd for Dalecarlia and 65 mgd for McMillan.

Two separate conditions were considered for the McMillan plant: one assumed that the historical pH value increased by 0.3 prior to reaching the plant, while one assumed that no pH change occurred. This accounts for the pH change that has been found to occur at times as the water crosses the McMillan reservoir from the East Shaft, where the pH is measured, to the plant intake. Factoring in this pH change lowers the estimated lime and caustic soda requirements and increases the estimated sulfuric acid requirements.

Table 3.10 shows the daily chemical doses used to estimate the number of truck deliveries per month, while Table 3.11 shows the actual number of monthly truck deliveries using the expected average doses, calculated using the RTW model corrections determined by the bench-scale study.

For Dalecarlia Scenario A was recommended – lime plus caustic trim. Therefore, the truck deliveries would be expected to increase by an average of 1.25 trucks/month over the current lime only truck deliveries.

Table 3.10

Average monthly doses used to calculate monthly truck deliveries

		Dalecarlia		**McMillan with pH Change**		**McMillan without pH Change**	
		Scenario A	Scenario B	Scenario A	Scenario B	Scenario A	Scenario B
Lime (mg/L as $Ca(OH)_2$)	Expected Average Dose	3.37	N/A	0.03	N/A	0.66	N/A
	Highest-Estimated Average Dose	6.28	N/A	0.16	N/A	1.84	N/A
Caustic Soda (mg/L as NaOH)	Expected Average Dose	2.67	6.31	0.39	0.43	1.96	2.68
	Highest-Estimated Average Dose	2.84	9.62	1.00	1.17	2.83	4.81
Sulfuric Acid (mg/L as H_2SO_4)	Expected Average Dose	N/A	N/A	0.66	0.66	0.01	0.01
	Highest-Estimated Average Dose	N/A	N/A	1.01	1.01	0.04	0.04

Table 3.11

Monthly truck deliveries required using expected average doses based on bench scale work

	pH control chemical deliveries		
	Dalecarlia	McMillan with pH change	McMillan without pH change
	Caustic @ 25%	Caustic @ 25%	Caustic @ 25%
Baseline	6.75	2.42	2.42
"Lime Only"	2.33	0.42	0.75
Scenario A	8.00	0.92	3.08
Scenario B	14.00	0.92	3.83
Scenario A Increase Over Baseline	**1.25**	**(1.50)**	**0.67**
Scenario B Increase Over Baseline	**7.25**	**(1.50)**	**1.42**

For McMillan, Scenario B is recommended—caustic without lime. The data collected over the 6 to 8 week time period indicated that there is a pH increase through the reservoirs; this conclusion is logical at least for algae growth months and is supported by staff experience. If it is assumed there is a pH increase year round through the reservoirs, there would be an average of 1.50 less trucks per month then the current baseline. If no pH increase takes place through the reservoirs, the truck traffic is expected to increase by 1.42 trucks per month. Since it is likely that sometimes there is a pH increase while at other times there is not, basically splitting the difference results in the truck traffic for caustic/acid at McMillan being essentially be the same as the current lime traffic.

CHAPTER 4
PACl

Both Dalecarlia and McMillan currently utilize alum for coagulation. As directed in the scope of services, the Washington Aqueduct is considering switching to polyaluminum chloride (PACl) for use as a primary coagulant.

The following sections will discuss the effectiveness of PACl as a coagulant, and the effect switching coagulants is expected to have on disinfection by-product (DBP) formation. Additionally, the impact that switching coagulants will have on the pH control strategy for Dalecarlia and McMillan will be discussed. This will be followed by a discussion of storage, delivery, and handling requirements for PACl.

PACl TREATMENT STUDIES

To evaluate the effectiveness of PACl, EE&T initially performed three sets of jar tests to determine the optimal PACl dose relative to full-scale plant use of alum for raw water conditions on May 10, 2006 at the Dalecarlia WTP. The jar tests were performed in accordance with the Washington Aqueduct's procedure to simulate the full scale system at Dalecarlia WTP. The procedure includes a rapid mix in the jar of 90 to 100 rpm for 2 minutes to simulate the hydraulic mixing at the flumes (G~ 120/s, Gt~ 14,440) and flocculation at 15 to 18 rpm for 25 minutes (G~ 8/s). The settling times established by the Washington Aqueduct were 6 and 13 minutes, which correspond to sedimentation basin overflow rates of 0.41 and 0.19 gpm/ft^2, respectively. EE&T recorded turbidity at these two time intervals, plus an additional sample at 10 minutes settling time (corresponding to overflow rate of 0.25 gpm/ft^2).

On May 10, 2006 EE&T obtained raw water and coagulant samples from the Dalecarlia WTP. The full-scale plant alum dose on that day was 260 lb/MG, or 31 mg/L as alum on a dry-weight basis. The PACl product used for the jar tests, DelPAC 2500, is a high basicity product produced by Delta Chemical, the supplier of the current alum product used at the two plants. The four PACl doses targeted for jar testing were 16, 23, 31, and 39 mg/L as product. Table 4.1 identifies the equivalent doses of dry alum needed to add the same amount of coagulant metal (Al^{3+}) for each of these PACl doses.

Table 4.1

Jar test PACl doses and corresponding dry alum equivalent doses producing the same aluminum dose

PACl dose (mg/L as product)	Aluminum dose (mg/L as Al)	Dry alum equivalent (mg/L as dry alum)
16	1.06	11.8
23	1.52	16.9
31	2.05	22.8
39	2.57	28.6

The raw water characteristics of the Dalecarlia raw water on this date included the following:

a. calcium hardness = 88 mg/L as $CaCO_3$

b. alkalinity = 76 mg/L $CaCO_3$

c. TOC = 2.95 mg/L

d. pH = 7.9, and

e. turbidity from 24 to 36 ntu

The first round of jar tests consisted of four jars dosed at the PACl doses listed in Table 4.1 without pH adjustment ("pH float"). While the jar dosed at 16 mg/L as product (i.e. neat) produced the largest floc size, the jars dosed at 31 and 39 mg/L neat resulted in lowest turbidity as depicted in Figure 4.1.

The second round of jar tests used the same PACl dose with pH adjusted to about 6.5 using sulfuric acid. The two higher doses again removed most of the turbidity, with settled turbidity of 1.3 ntu after 13 minutes of settling time, as shown in Figure 4.2.

The third round of testing was similar, except targeting a coagulation pH of 6.2. The PACl dose of 31 mg/L as product removed the greatest amount of turbidity, measuring 1.8 ntu after 13 minutes of settling, as depicted in Figure 4.3.

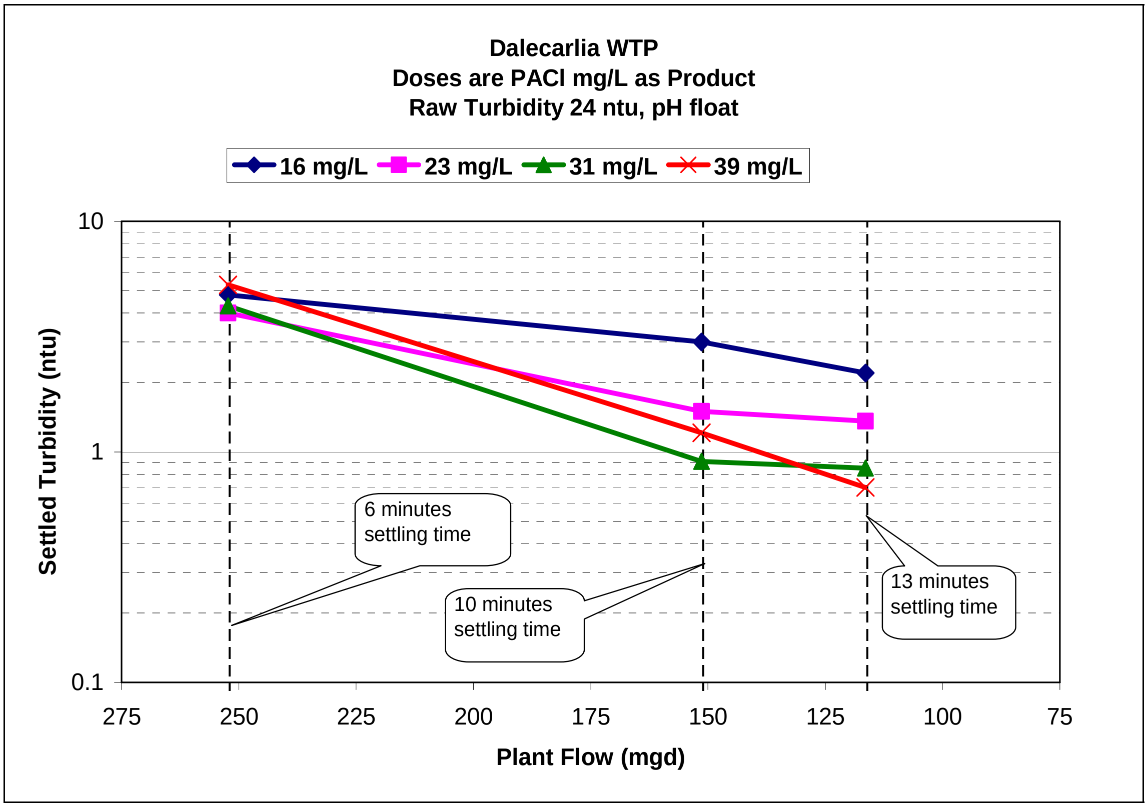


Figure 4.1 Turbidity versus overflow rate for "pH float" jars

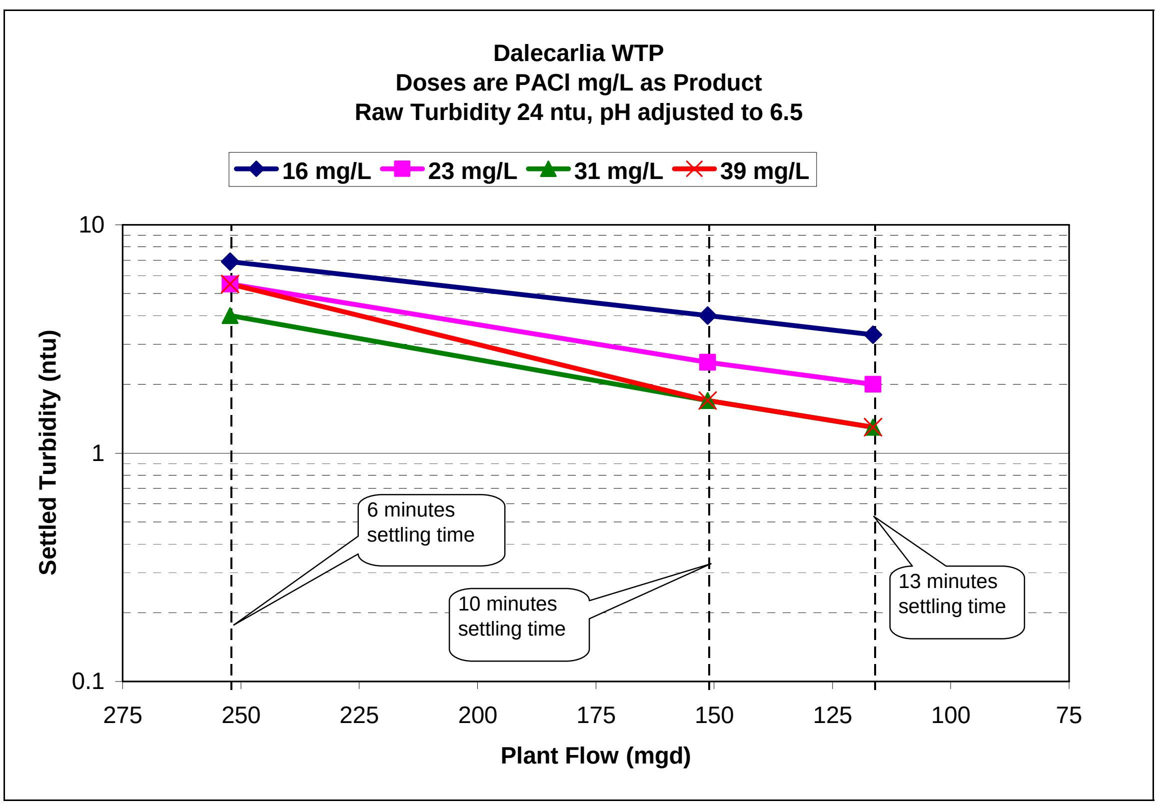


Figure 4.2 Turbidity versus overflow rate for jars adjusted to pH 6.5

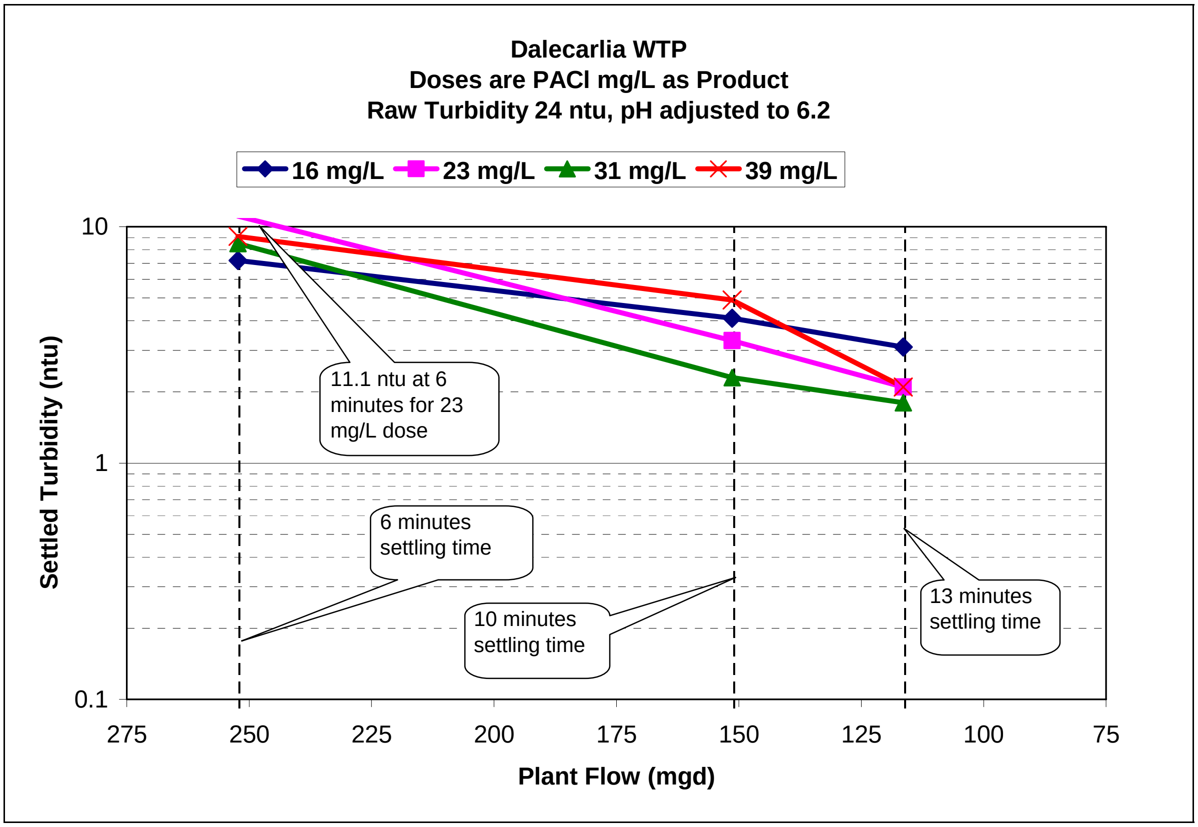


Figure 4.3 Turbidity versus overflow rate for jars adjusted to pH 6.2

Figures 4.4 and 4.5 summarize the results from all three sets of jar tests. Figure 4.4 is a plot of PACl dose versus coagulation pH, with the settled dissolved organic carbon (DOC) value listed for each data point (TOC measured after centrifuging the treated sample to remove particulate TOC). Figure 4.5 shows turbidity after 13 minutes of settling time (corresponding to a flow of 116 mgd) versus PACl dose, along with the corresponding TOC removal percent value (relative to 2.95 mg/L TOC in raw water) for each data point.

Decreasing the coagulation pH slightly improved DOC removal but produced poorer turbidity removal under the conditions tested. This is typical, and usually EE&T has found that adding a polymer is necessary to compensate for poorer turbidity removal at the lower coagulation pH. Under the conditions tested, TOC removal was however only slightly improved at the lower pH, and probably not a sufficient improvement to justify the increased cost and operational complexity associated with acid addition. Consequently, under the conditions tested with the PACl product, it is not recommended to adjust pH through acid addition.

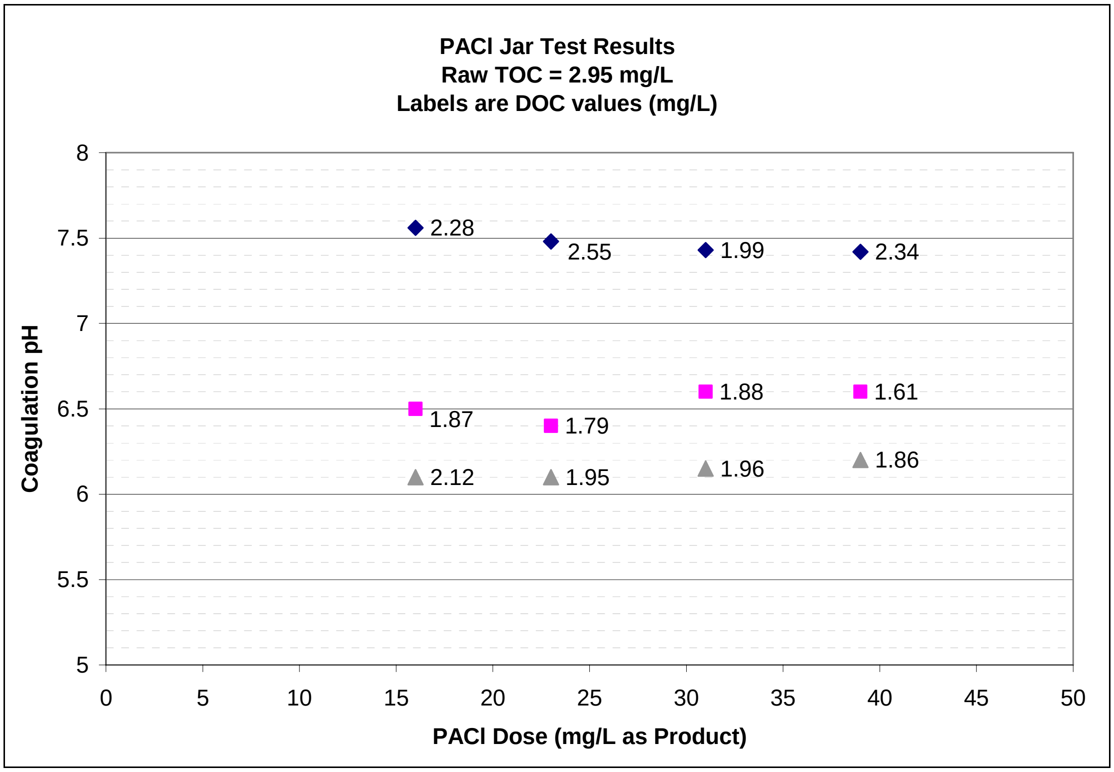


Figure 4.4 Treated DOC for jar test pH and PACl dose during May 2006 studies

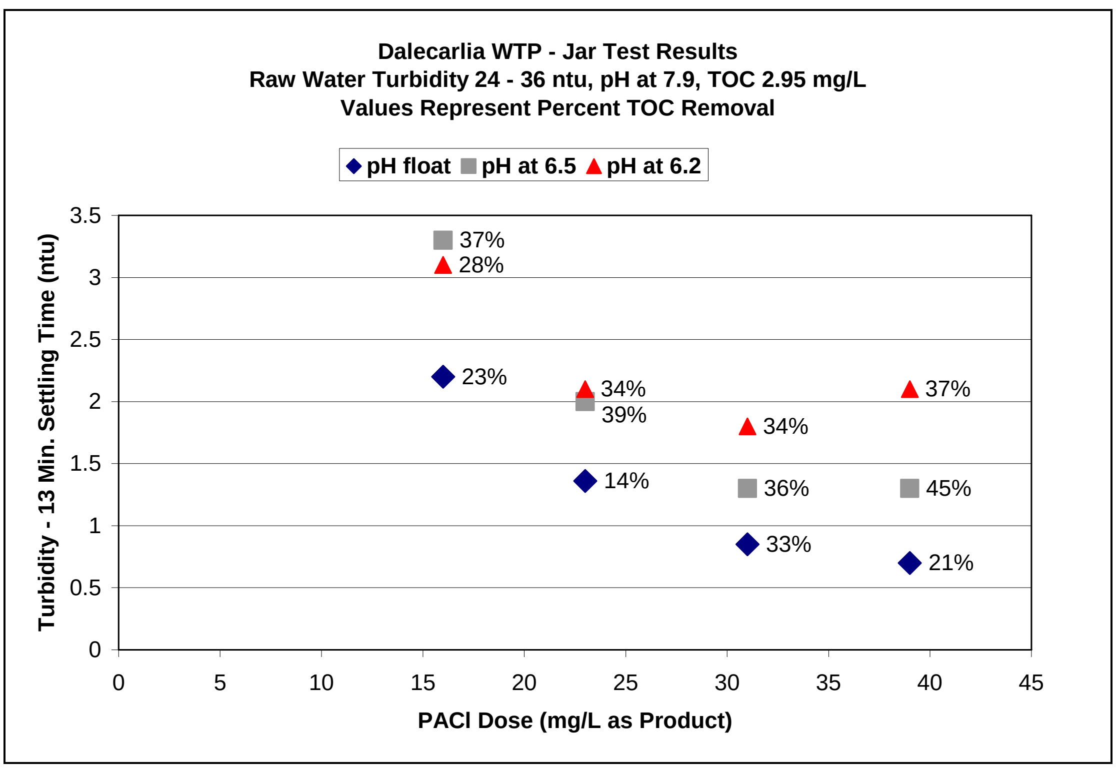


Figure 4.5 TOC and turbidity removal versus PACl dose during May 2006 jar tests

Under pH float conditions, a 31 mg/L PACl dose produced better TOC removal than the other three doses tested, and the settled water turbidity (less than 1 ntu at settling times greater than 10 min, or overflow rates less than 0.25 gpm/ft^2) was appreciably lower than the two lower doses (16 and 23 mg/L neat) and about the same as the higher dose (39 mg/L neat). Therefore, the 31 mg/L PACl dose produced the best TOC and turbidity removal combination under the conditions tested, appreciably better than at other PACl doses and acid addition combinations. This indicates that, for the raw water conditions on May 10, 2006, the optimal PACl dose in mg/L as product was equivalent to the optimal alum dose in mg/L as dry alum.

While the initial testing conducted using water collected on May 10, 2006 gave a good idea as the effectiveness of PACl for removing turbidity, the Washington Aqueduct wished to further analyze the effect of coagulation pH on the ability of PACl to remove DBP precursors. For this reason, additional jar testing was included as part of the bench-scale pH testing described in Chapter 3.

As part of this testing, Dalecarlia raw water was collected four times in an effort to analyze the effects of alternative treatment chemicals the Washington Aqueduct is considering for use at Dalecarlia WTP and McMillan WTP. One of the proposed treatment chemical changes is a switch from alum to PACl for coagulation. Multiple jar tests were performed using PACl for coagulation of the collected raw water at four different coagulation pH values. The four pH values are described below:

1. **Target pH** - Discussions with the Washington Suburban Sanitary Commission (WSSC) indicated that the WSSC has found that a pH between 6.3 to 6.5 is optimal for DBP precursor removal at their Potomac River plant. Based on these discussions, jar tests were conducted using a coagulation pH of 6.5. Jar tests performed at this pH value were identified as “Target pH” jar tests.
2. **Alum pH** - Jar tests were conducted at the coagulation pH that was recorded at the Dalecarlia WTP on the day the raw water samples were collected. The pH values of coagulation ranged near 7.0. Jar tests performed at these pH values were identified as “Alum pH” jar tests.
3. **Float pH** - Jar tests were also conducted without controlling the coagulation pH. During these tests, the coagulation pH levels were allowed to “float” with only the

PACl dose controlling the pH. Jar tests performed at these pH values were identified as “Float pH” jar tests.

4. **7.5 pH** - Following further discussions with the WSSC, EE&T was informed that, after switching from alum to PACl, the WSSC found depressing the raw water pH to 7.5 prior to coagulation addition minimized aluminum residuals throughout the plant. Based on this information, jar tests were performed at a coagulation pH of 7.5. These jar tests were identified as “7.5 pH” jar tests.

The water was collected on four separate occasions dating from September 18 to November 6, 2006. Alum doses were recorded each day water was collected and were used as a basis for the doses of PACl chosen for the jar tests. Four PACl doses were selected for each round of jar test, based on the alum dose the day the water was collected. Generally, the PACl doses selected were approximately 50, 75, 100 and 125 percent of the alum dose for that day. The PACl doses were measured as product as opposed to the alum, which was measured by dry weight. Therefore, the PACl doses selected were approximately 30 percent lower than the alum dose on an aluminum weight basis.

Each jar test was performed using the same rapid-mix flocculation and settling conditions. The jars were evaluated for turbidity removal, DOC removal, UV_{254} removal, and dissolved aluminum residuals. Simulated distribution system (SDS) tests were also performed using the coagulated water from the jar tests and analyzed for DBP formation. Because chloramination is used at the Dalecarlia plant, it was assumed the only DBP formation would be that which occurs within the plant itself. Therefore, the duration of the SDS tests were limited to the residence time in the first clear well, which typically ranged from 3.25 to 5.5 hours (4 hours was used in the SDS tests).

September 18, 2006 Water Sample

Water collected on the September 18, 2006 was put through jar tests involving methods 1, 2, and 3 described above. The raw water contained a DOC concentration of 3.71 mg/L, UV_{254} of 0.048 cm^{-1}, 85 mg/L as $CaCO_3$ for alkalinity, and 98 mg/L as $CaCO_3$ for hardness. Figures 4.6 through 4.9 show the results obtained from the jar tests results.

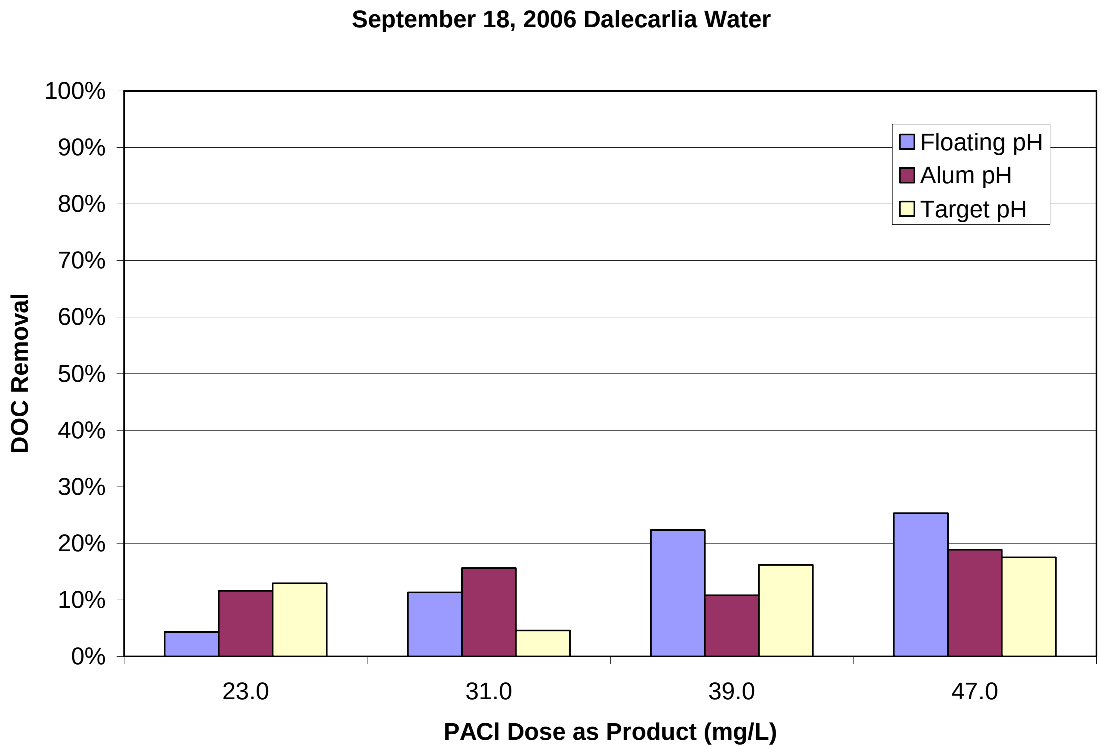


Figure 4.6 DOC removal by PACl dose (09/18/06 sample)

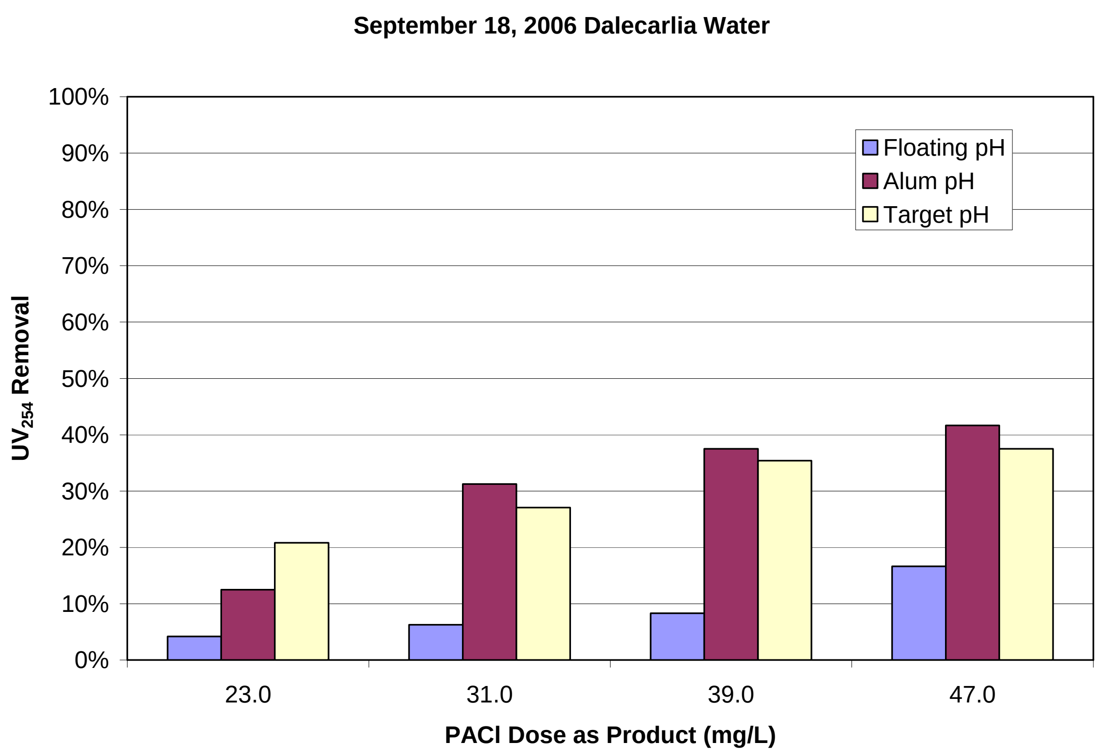


Figure 4.7 UV_{254} removal by PACl dose (09/18/06 sample)

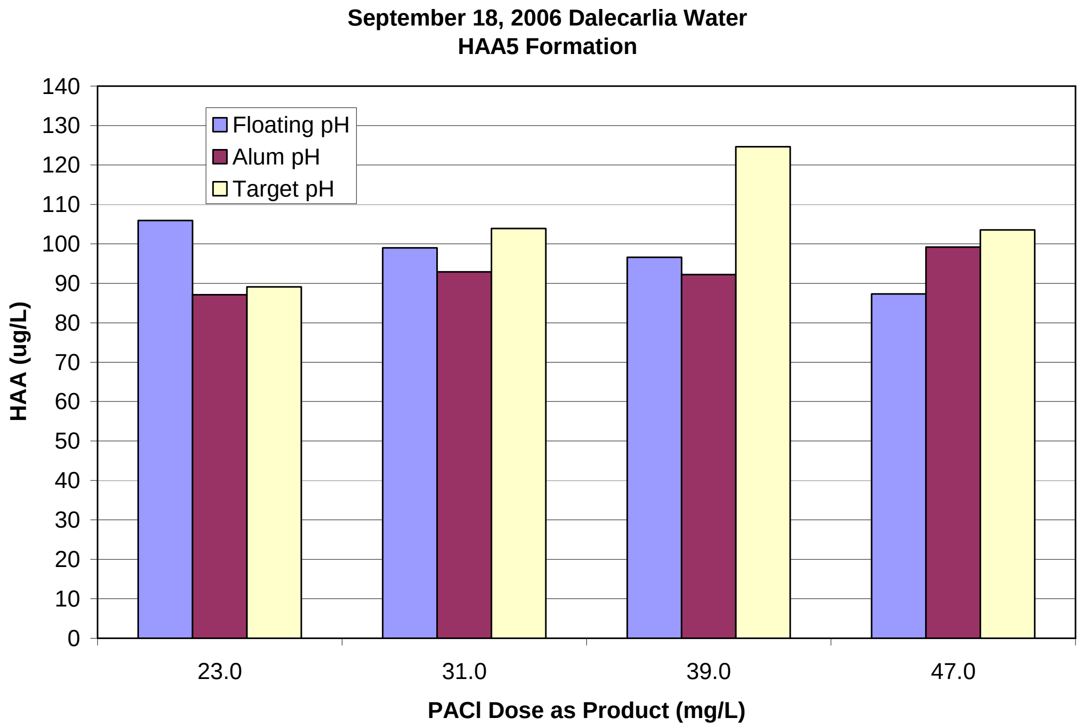


Figure 4.8 HAA formation by PACl dose (09/18/06 sample)

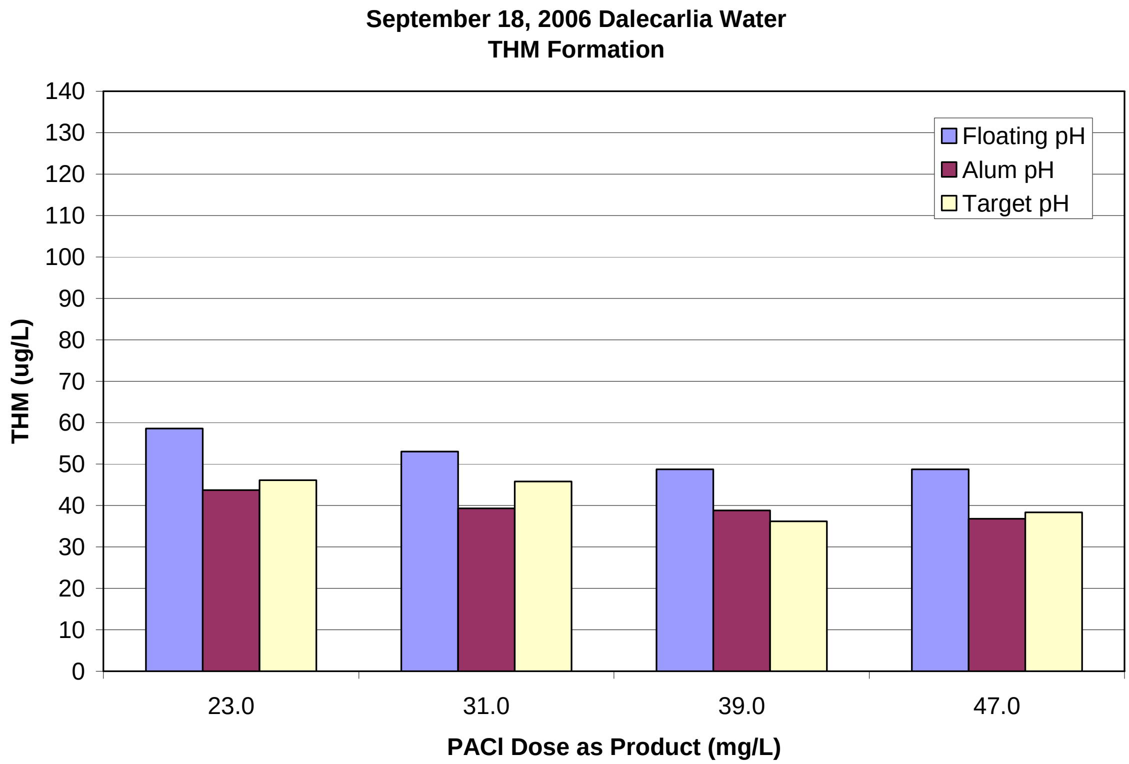


Figure 4.9 THM formation by PACl dose (09/18/06 sample)

As expected, as the PACl dose increased the UV_{254} removal increased correspondingly. UV_{254} is a measure of the amount of ultraviolet radiation absorbed by the sample at a wavelength of 254 nm. Organic compounds, particularly those that contain aromatic rings, absorb ultraviolet radiation at this wavelength; therefore, the level of UV_{254} provides a measure of the amount and the type of organic compounds that are present. The trend between PACl dose and UV_{254} was generally observed with the DOC as well, with some exceptions. Interestingly, while lowering the coagulation pH significantly increased UV_{254} removal, this trend was not observed for the DOC removal.

DBP formation was not improved by lowering the coagulation pH. This is at least partially due to the use of chloramines as the secondary disinfectant. Note that the halogenated acetic acid (HAA) values were unusually high in the September 18, 2006 sample, although all internal QA/QC checked out.

October 2, 2006 Water Sample

Water collected on October 2nd was put through the same three jar tests as the previous sample. The PACl doses used were changed slightly so that the third highest PACl dose matched the alum dose on the day the water was collected. The DOC concentration in the raw water was slightly less than the September sample decreasing from 3.71 mg/L to 3.06 mg/L. UV_{254} remained the same as Round 1 with a value of 0.047 cm^{-1}. Alkalinity and total hardness both increased compared to the September sample measuring 105 mg/L as $CaCO_3$ and 104 mg/L as $CaCO_3$, respectively. Figures 4.10 through 4.13 show the results of this round of jar testing.

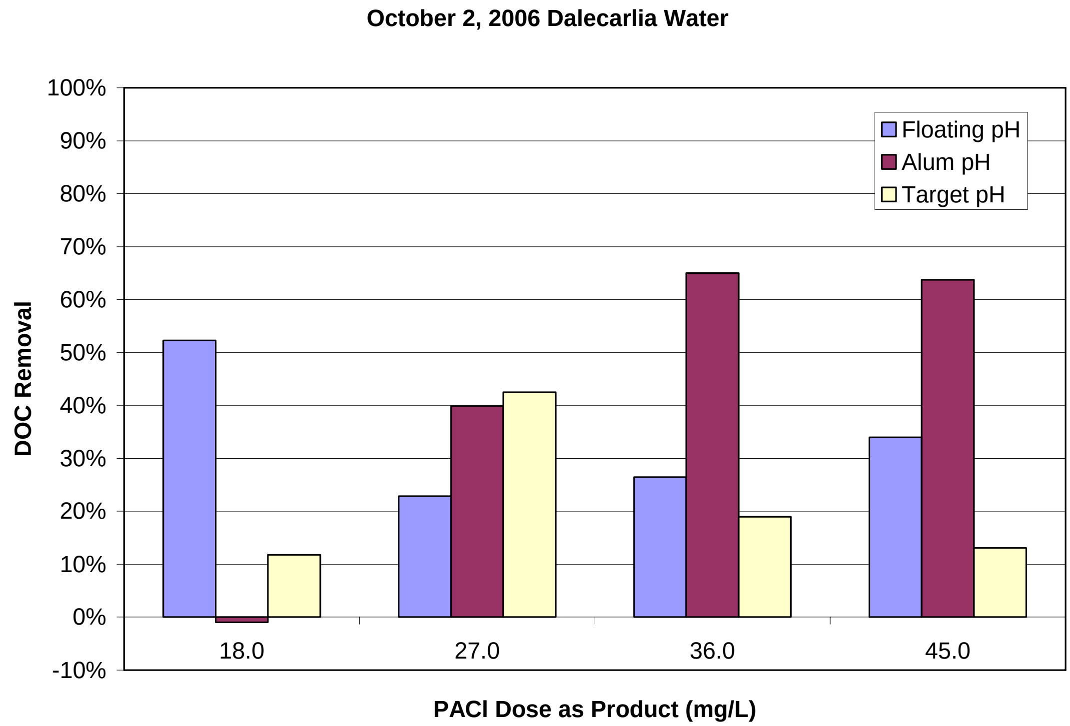


Figure 4.10 DOC removal by PACl dose (10/02/06 sample)

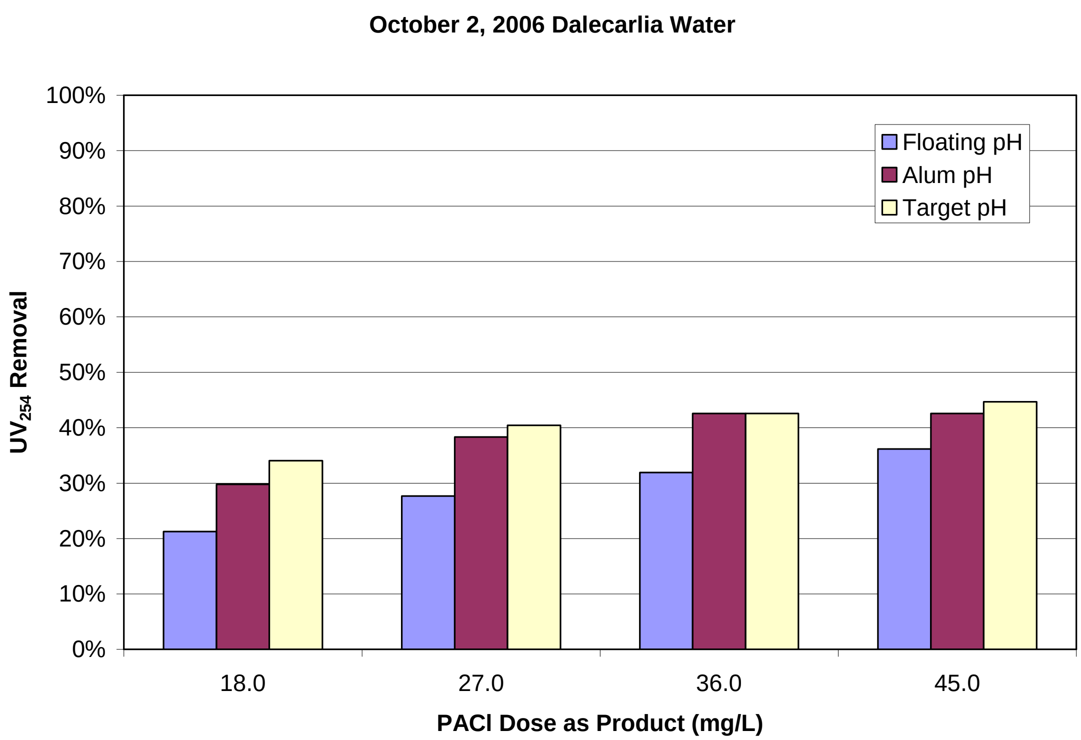


Figure 4.11 UV_{254} removal by PACl dose (10/02/06 sample)

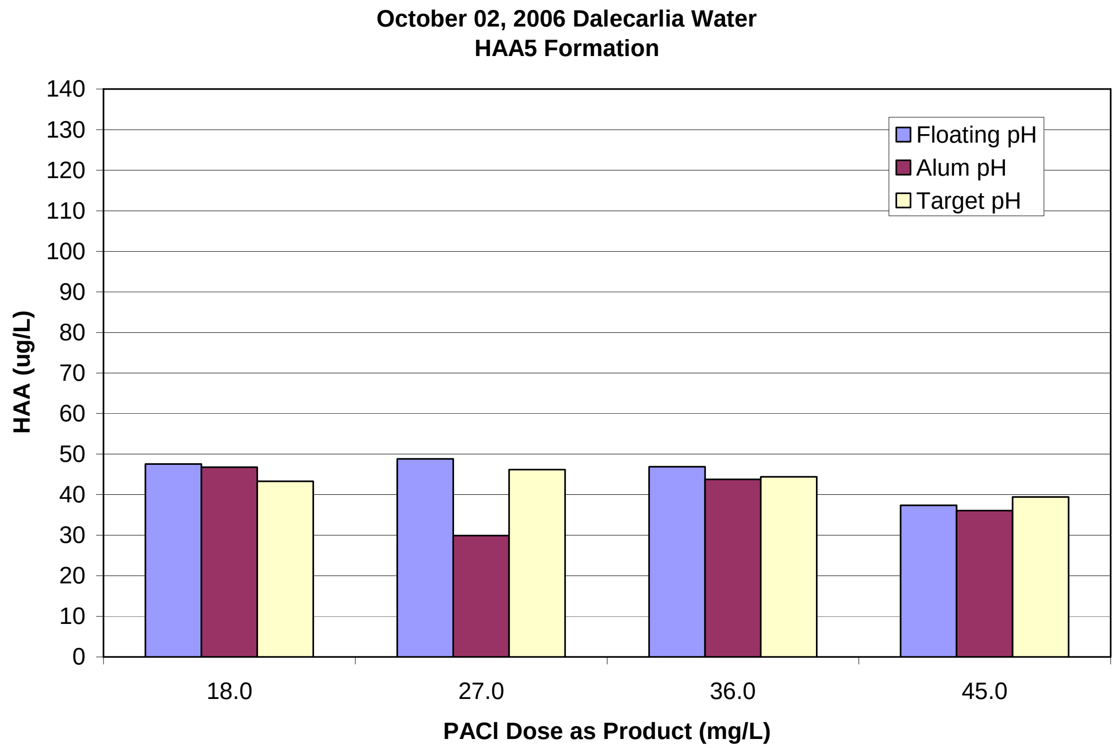


Figure 4.12 HAA formation by PACl dose (10/02/06 sample)

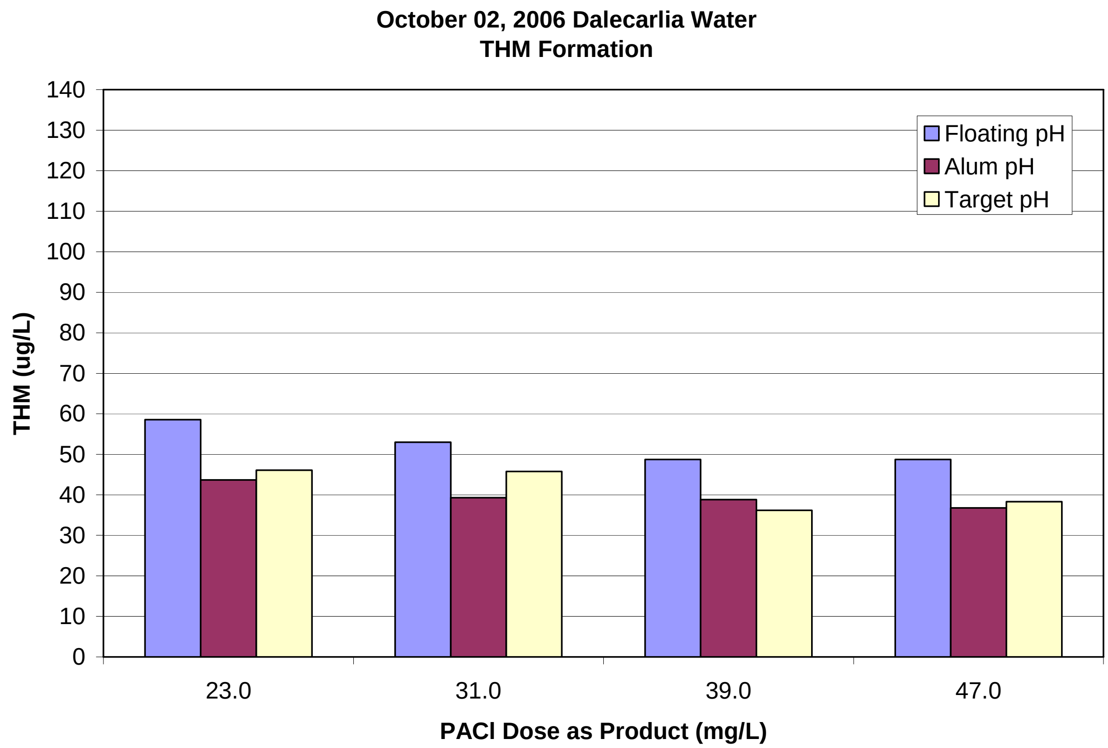


Figure 4.13 THM formation by PACl dose (10/02/06 sample)

Showing similar results to the previous set of sampled water, UV_{254} removal increased both as the PACl dose was increased and as the coagulation pH was lowered. Neither trend was observed with respect to DOC.

The HAA concentrations from the SDS tests appeared to be in the normal range expected for Dalecarlia WTP as opposed to the high HAA levels from Round 1. Given the relatively large range of error present in HAA analysis, the HAA measurements appear to be relatively similar between each coagulation pH tested. Regarding trihalomethane (THM) formation, it appears the jars at highest coagulation pH produced slightly higher THM levels than the other jars, but again, given the precision of THM analysis it is difficult to draw definite conclusions.

October 11, 2006 Water Sample

The third set of water retrieved from Dalecarlia WTP was collected on October 11, 2006. The UV_{254} in the raw water measured at 0.056 cm^{-1}, while alkalinity and total hardness rose to 113 and 108 mg/L as $CaCO_3$ respectively. Figures 4.14 through 4.17 represent the results found in the third round of jar testing.

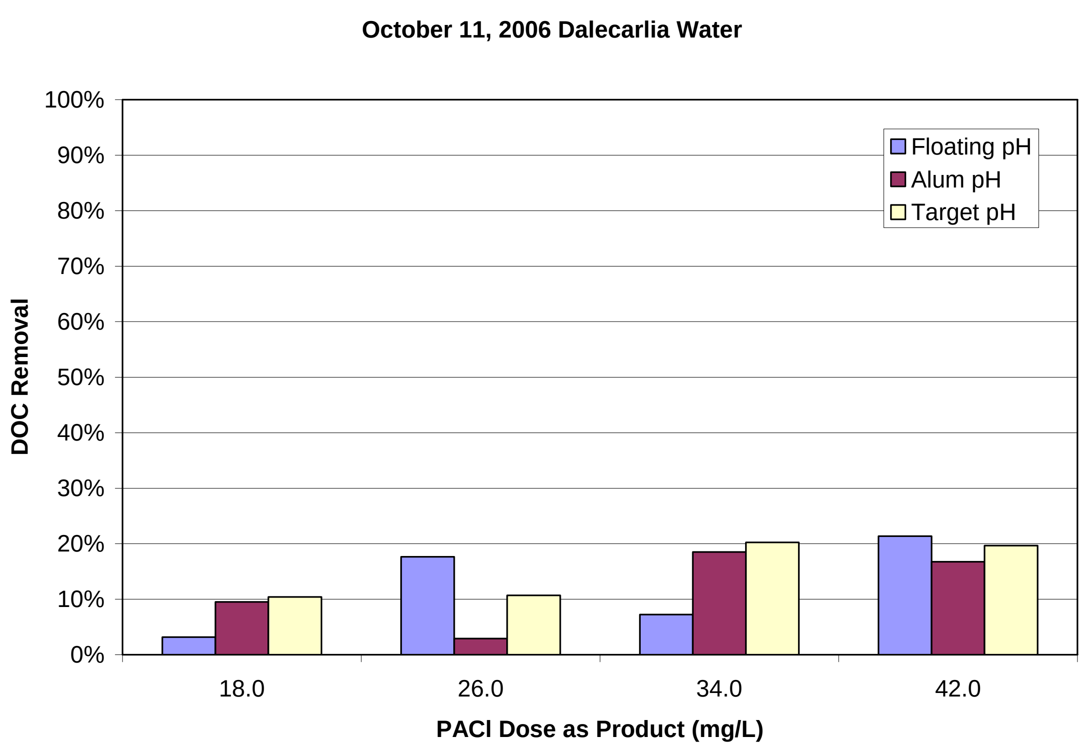


Figure 4.14 DOC removal by PACl dose (10/11/06 sample)

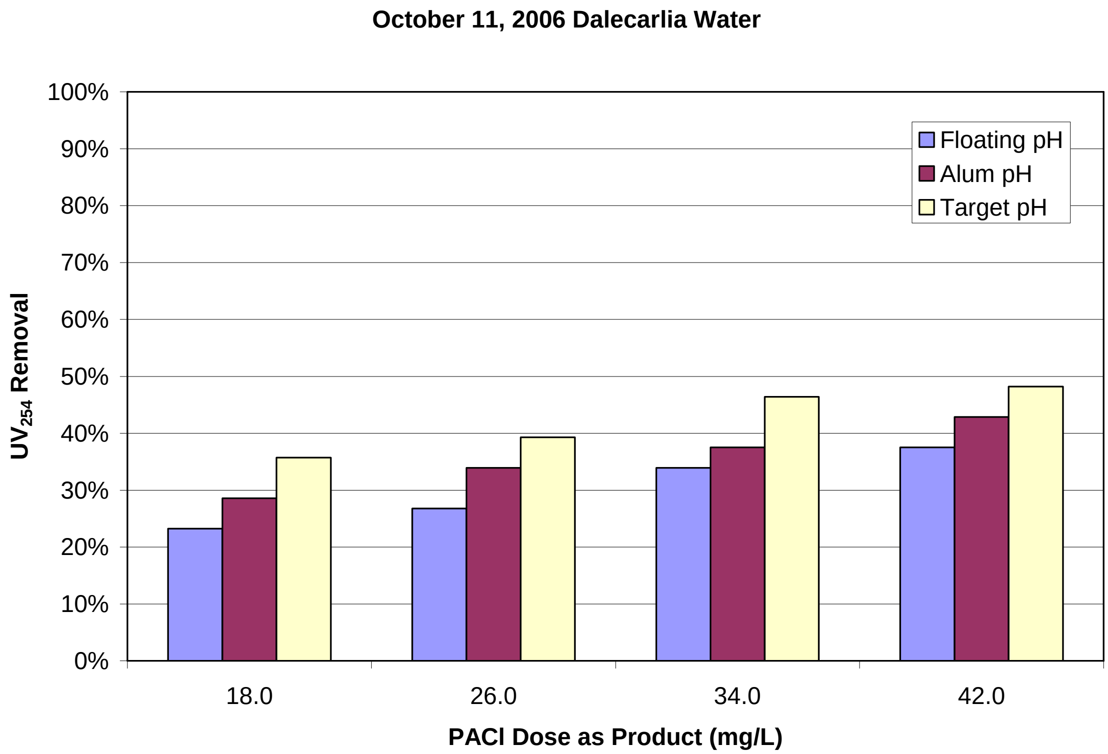


Figure 4.15 UV_{254} removal by PACl dose (10/11/06 sample)

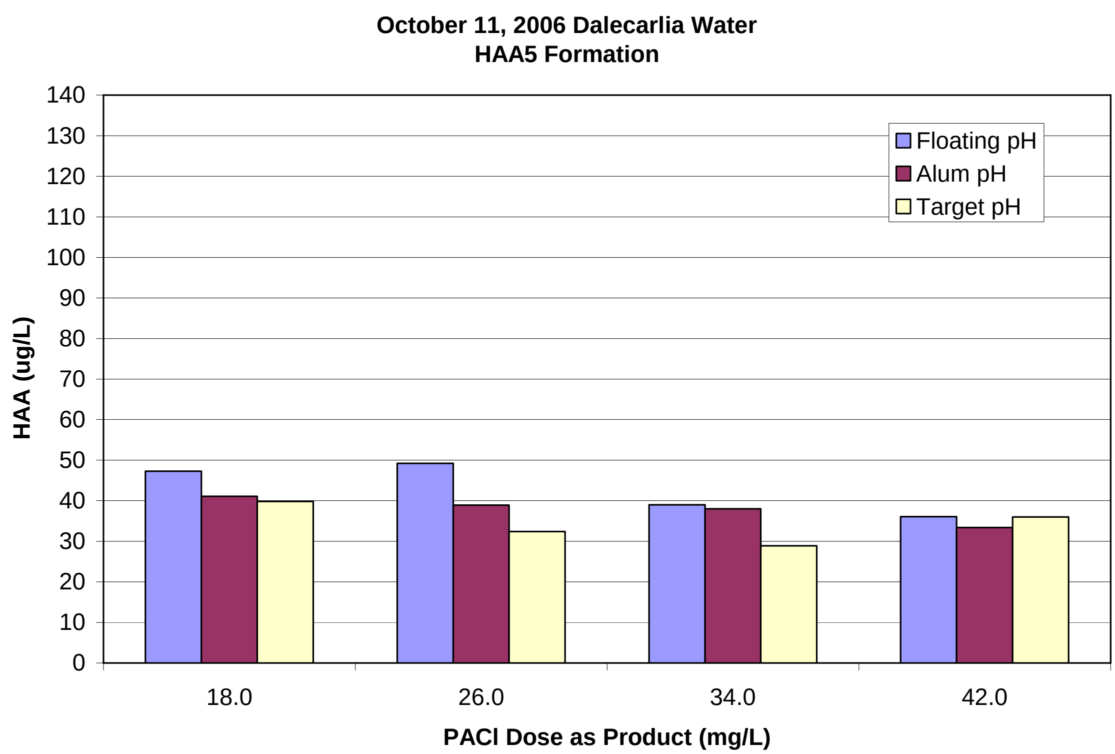


Figure 4.16 HAA formation by PACl dose (10/11/06 sample)

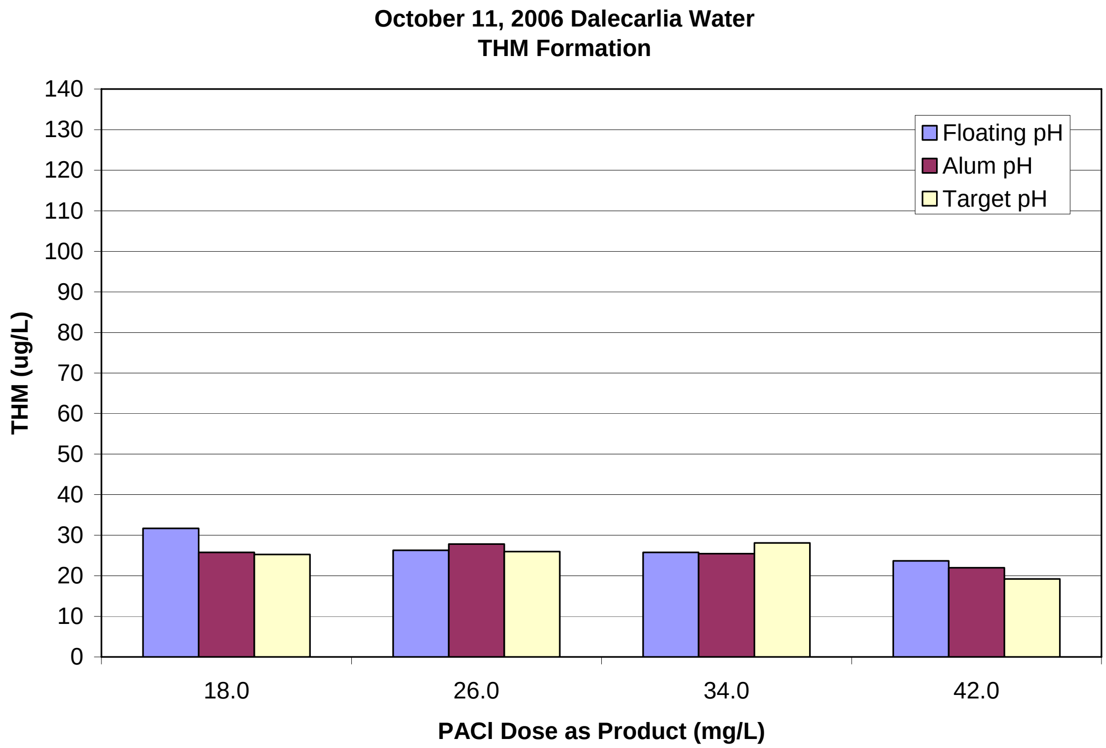


Figure 4.17 THM formation by PACl dose (10/11/06 sample)

Overall, DOC removal was lower in Round 3 than in either of the previous rounds of testing, although DOC removal at the highest coagulation pH is slightly higher at some coagulant doses than during Round 1. Again, no trend is evident between the coagulation pH and the level of DOC removal. UV_{254} removal followed the same trends observed in Rounds 1 and 2.

As in Round 2, HAA formation was closer to levels expected for Dalecarlia WTP. Again, it appears that THM formation was highest in the jars coagulated at the highest pH, although overall THM formation is still reasonably low.

November 6, 2006 Water Sample

The jar testing program was condensed for the last set of water, which was collected from Dalecarlia WTP on November 06, 2006. Only two pH values were selected for the coagulation: the “target pH” of 6.5, similar to the previous three rounds, and a coagulation pH of 7.5, which the Washington Suburban Sanitary Commission has found to reduce aluminum residuals.

The raw water contained 5.08 mg/L of TOC and 4.86 mg/L of DOC. With a UV_{254} value of 0.101 cm^{-1}, this sample demonstrated the highest reading for UV_{254} EE&T had observed since the start of the testing. Alkalinity and hardness concentrations decreased from the last sample measuring at 84 mg/L and 93 mg/L as $CaCO_3$, respectively. Figures 4.18 through 4.21 display the results for this round of testing at the two coagulation levels.

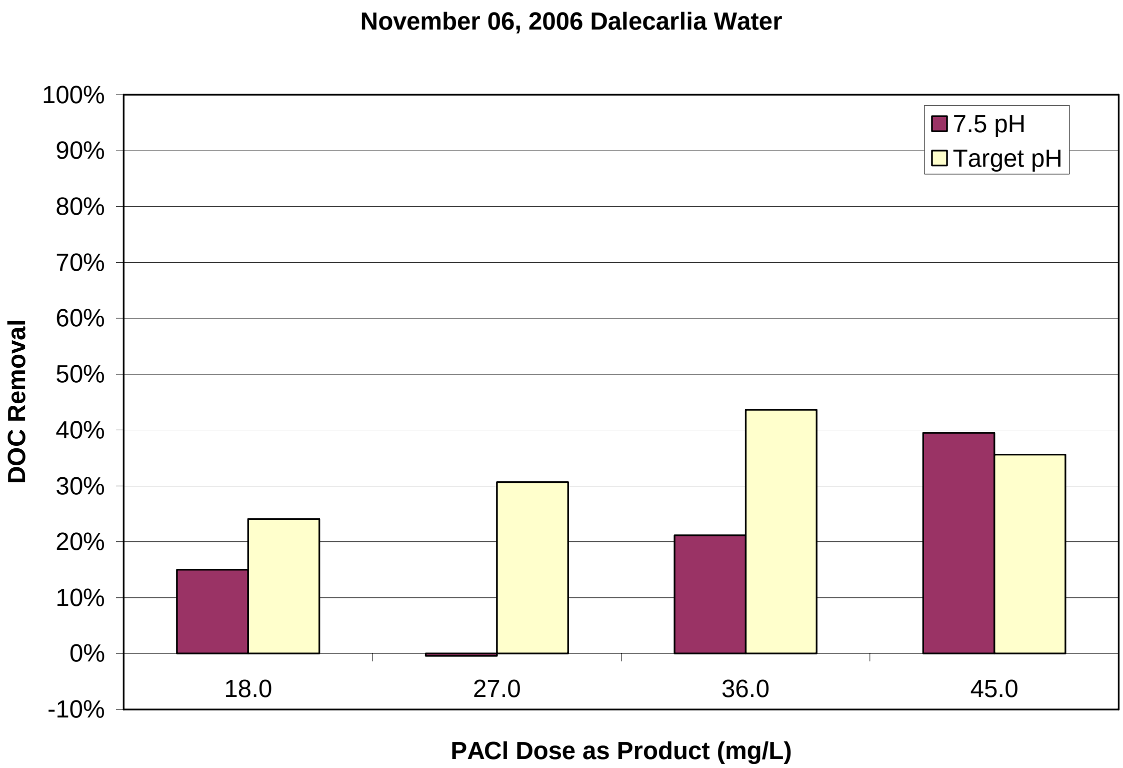


Figure 4.18 DOC removal by PACl dose (11/06/06 sample)

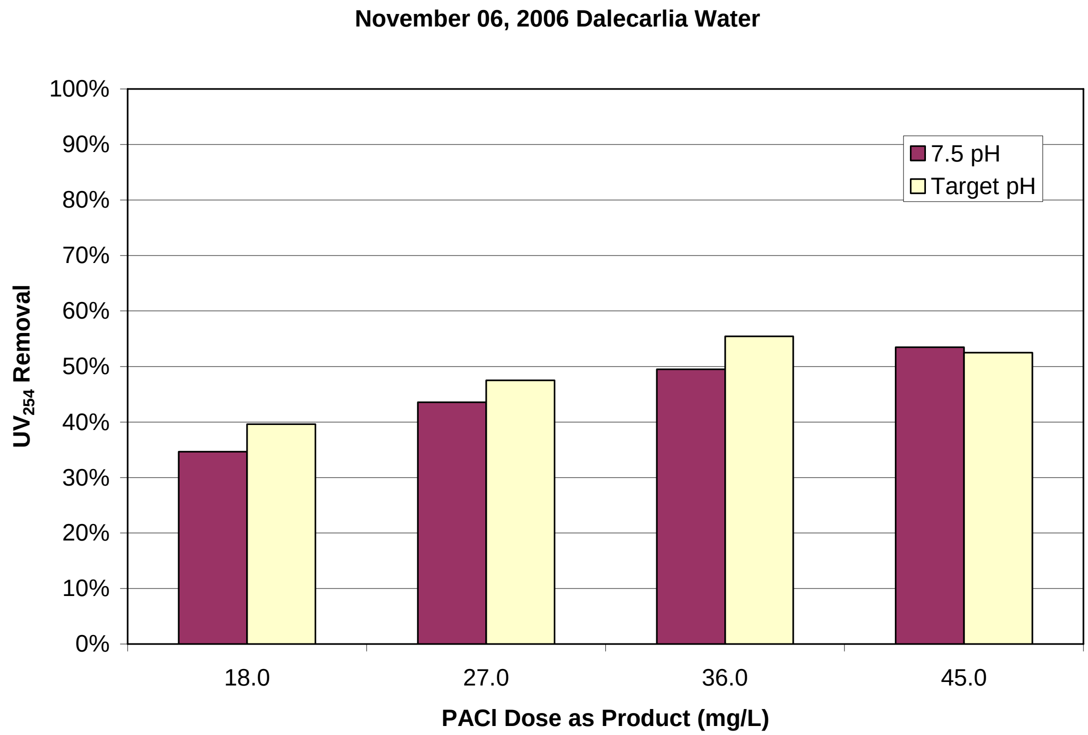


Figure 4.19 UV_{254} removal by PACl dose (11/06/06 sample)

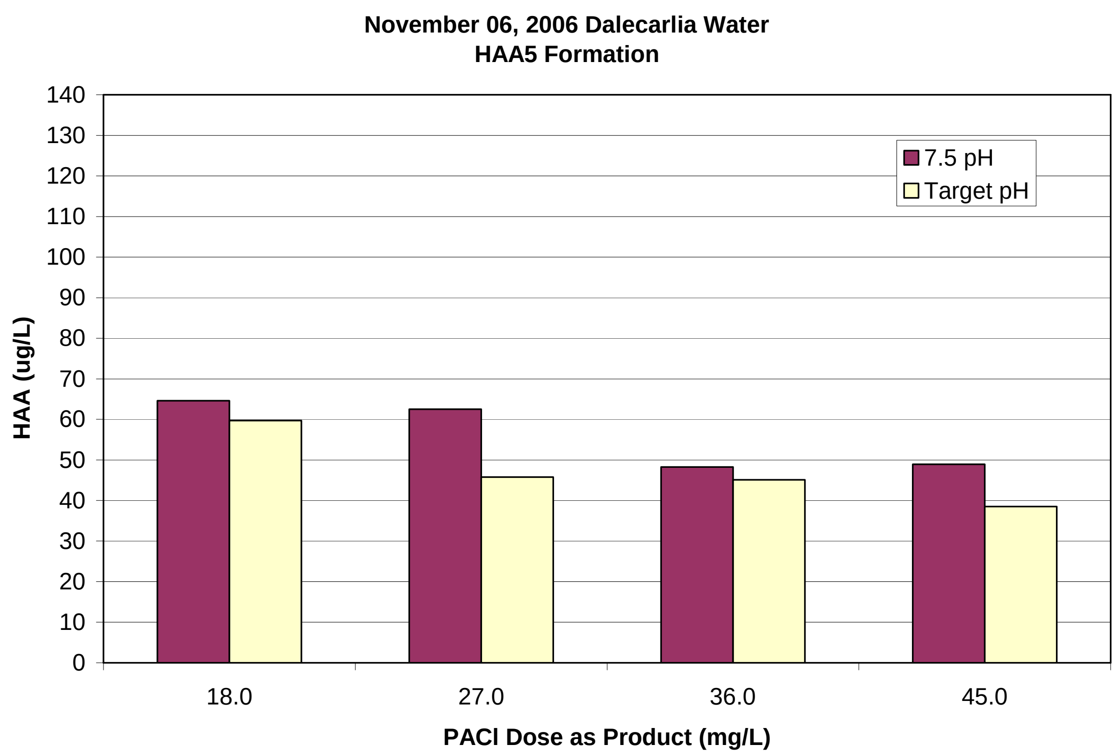


Figure 4.20 HAA formation by PACl dose (11/06/06 sample)

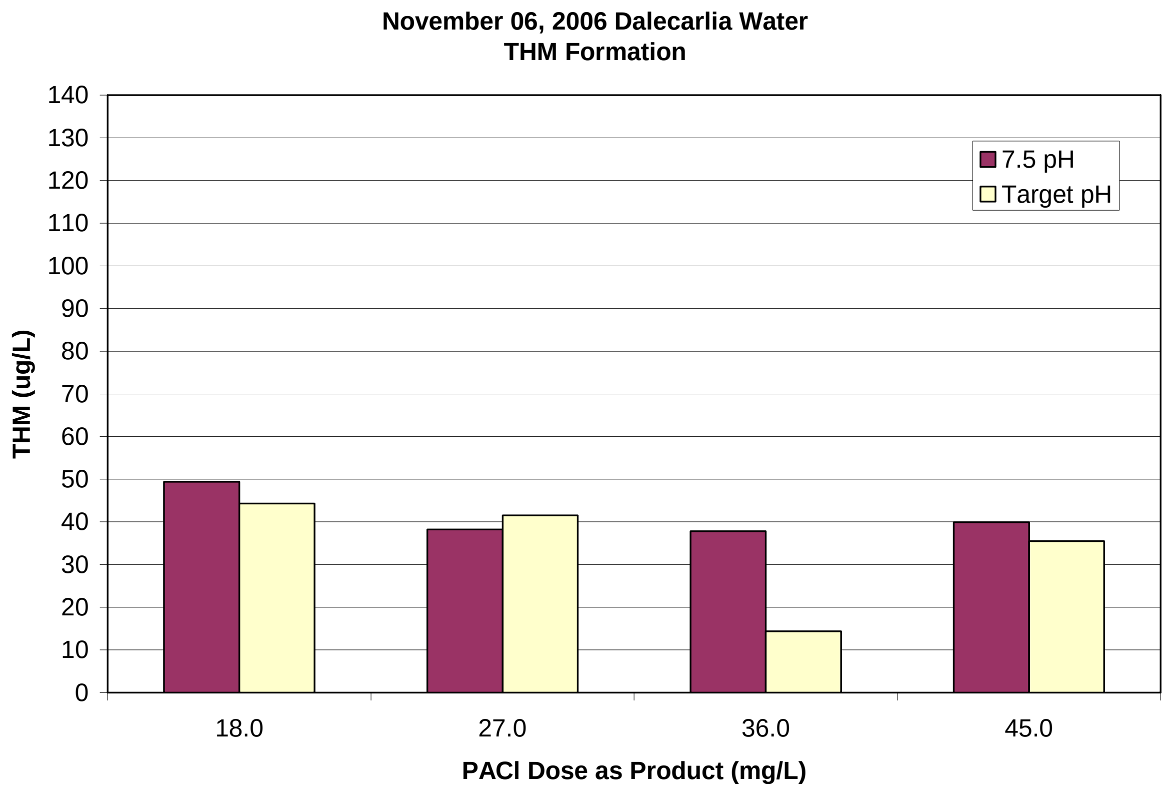


Figure 4.21 THM formation by PACl dose (11/06/06 sample)

The water coagulated at the target pH removed a greater percentage of DOC and UV_{254} except at the largest dose as compared to water coagulated at a pH of 7.5 (first set at 7.5 tested).

However, when comparing HAA and THM formation data, there is no clear indication that the lower coagulation pH significantly reduces DBP formation. While the samples coagulated at the lower pH tended to have lower HAA and THM levels, the majority of the tests showed less than 20 percent variation between the samples coagulated at a pH of 7.5 compared to samples coagulated at a pH of 6.5.

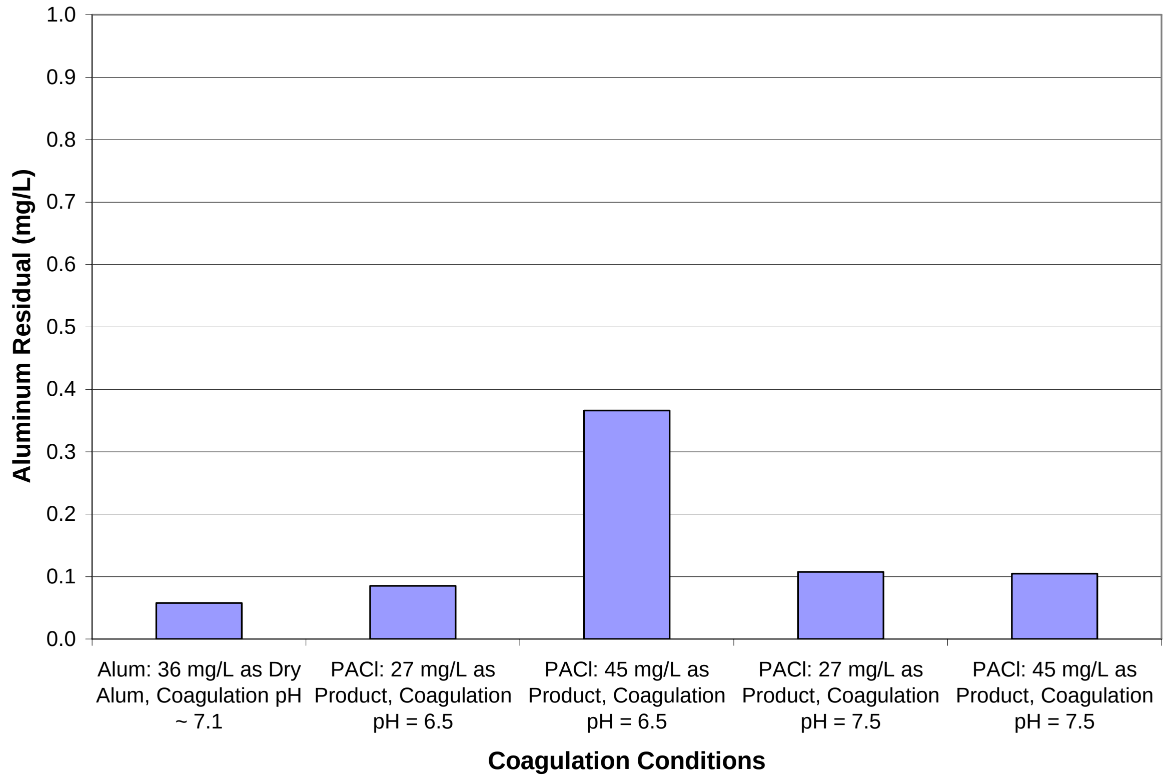


Figure 4.22 Aluminum residuals from Round 4 jar tests

Aluminum tests were conducted on finished jar test water from the fourth test. These tests were performed by the Washington Aqueduct at the request of EE&T. Figure 4.22 below shows the aluminum concentrations for alum and PACl. Although one of the two samples analyzed from coagulation with a pH of 6.5 showed a higher level of aluminum residual, no conclusions can be drawn from the limited amount of data available. At this point EE&T is relying on WSSC and FWA experience that controlling the coagulation pH to 7.5 when using PACl is optimal for controlling aluminum residuals. Clearly this is an area where the Washington Aqueduct will also need to gain plant data experience if it makes the coagulant switch to PACl.

Overall, the results from all four rounds of testing indicate that, while lowering the coagulation pH may increase the level of DOC and UV_{254} removal, it does not significantly lower the level of DBP formation. It is likely that the lack of reduction in DBP formation is linked to the fact that the Washington Aqueduct uses chloramination; there is only a small window of a few hours between the chlorine dose and the formation of chloramines when DBPs could form (other than some likely small increase after chloramination). For this reason, along with the fact that large amounts of sulfuric acid and lime are needed to lower and then raise the pH pre- and post-coagulation, EE&T does not recommend that the coagulation pH be lowered for the purposes of DBP precursor removal when PACl is used for coagulation. However, EE&T does recommend that a small dose of acid be used prior to coagulation to lower the pH to 7.5, in order to reduce aluminum residuals in the finished water.

pH CONTROL WITH PACl

Much like switching from chlorine gas to sodium hypochlorite, switching from alum to PACl coagulation will impact the pH control strategy at Dalecarlia and McMillan. During the coagulation reaction, alum reacts with carbonate to form aluminum hydroxide. This reaction lowers the alkalinity in the system, which, in turn, lowers the system pH. Approximately 0.5 mg/L as $CaCO_3$ of alkalinity is consumed for every 1 mg/L as dry alum of alum added. Like alum, PACl also consumes alkalinity during the coagulation reaction, but the amount of alkalinity needed is much less (approximately 0.1 mg/L as $CaCO_3$ of alkalinity consumed for every 1 mg/L as product of PACl added). As discussed above, test results indicate that for Dalecarlia and McMillan, the optimal dose of PACl as product is approximately equal to the optimal dose of alum as dry alum. Therefore, the amount of alkalinity lost during coagulation will be approximately 20 percent of current levels if PACl is used for coagulation and, subsequently, less of a pH drop during coagulation will be experienced.

Discussion of Scenarios C and D in Chapter 3 details the impact switching to PACl will have on the on the lime, caustic soda, and sulfuric acid doses required at each plant. In general, switching to PACl will lower the amount of lime, caustic soda, and, at McMillan, sulfuric acid needed for final pH control. However, overall sulfuric acid use will increase, because it was assumed the raw water pH would be adjusted to 7.5 or less prior to coagulation to minimize aluminum residuals in the finished water.

The Washington Aqueduct also expressed concern that, beyond the impact on pH, switching to PACl might increase corrosion problems in the distribution system. In particular, anecdotal evidence suggests that utilities switching to PACl coagulation receive more complaints from customers regarding pinhole leaks in their plumbing following the switch. To investigate this matter, EE&T conducted a literature review and interviewed two other water utilities that use PACl for coagulation of Potomac River water: the Washington Suburban Sanitary Commission (WSSC) and the Fairfax Water Authority (FWA).

There were no studies found in the literature review that directly linked copper pitting, which causes pinhole leaks, to the use of PACl. While a definitive cause of copper pitting has not been identified, there is some evidence suggesting aluminum solids and chlorine can act together to initiate copper pitting. Based on this observation, EE&T looked to determine differences in aluminum residuals between PACl and alum, and generally found that aluminum residuals were lower following PACl coagulation than those following alum coagulation. Based on these studies, it appears that PACl might lower incidences of pinhole leaking in the distribution system. The literature review in its entirety can be found in Appendix A.

According to the interview with the WSSC, they did experience problems of pinhole leaks a few years ago. WSSC was using PACl for coagulation at that time, although there was no evidence of a direct link between PACl and the copper pitting problems. After implementing orthophosphate addition for corrosion control, the number of pinhole leak reports dropped. FWA also uses orthophosphate corrosion control, and has had few reports of pinhole leaks in their system.

Based on the literature and interviews, and the fact that the Washington Aqueduct currently adds orthophosphate for corrosion control, it does not appear that switching to PACl will increase copper pitting in the Washington Aqueduct distribution system.

STORAGE REQUIREMENTS AND TRUCK DELIVERIES VERUS ALUM

About one-half as much volume of the PACl product will be needed compared to alum at the two plants (on an aluminum basis) if it is assumed that the dry alum dose is about equal to the neat PACl dose found in the test. This is similar to the results found in a previous study by CH2M Hill, although they found that about 20 percent more PACl dose was needed. Using the median value from historical alum dosage (Jan. 2004 – Apr. 2006) of 31 mg/L as dry alum, Table 4.2 calculates the corresponding PACl and alum trucking requirements, and shows that less on-site storage and deliveries are needed for a 30-day supply of PACl (or, alternatively, current on-site storage would provide additional days). The same calculations were performed to determine storage and delivery estimates for the maximum alum dose (95th percentile); these data is shown in Table 4.3.

Table 4.2

Comparison of amount of the PACl needed versus alum at Dalecarlia and McMillan using median dose from historical data

Dry alum	Coagulant	Neat PACl
1.330	Specific gravity	1.279
5.38	Coagulant density (lb/gal)	10.67
	Dalecarlia	
132	Design plant flow (mgd)*	132
31	Median coagulant dose (mg/L)	31
34,127	Coagulant dose (lb/day)	34,127
6,343	Amount of coagulant used (gal/day)	3,198
190,301	30 day storage (gallons)	95,953
45	Number of truck deliveries per month	21
	McMillan	
74	Design plant flow (mgd)*	74
33	Median coagulant dose (mg/L)	33
20,366	Coagulant dose (lb/day)	20,366
3,786	Amount of coagulant used (gal/day)	1,909
113,567	30-day storage (gallons)	57,262
27	Number of truck deliveries per month†	13

*Provided by the Washington Aqueduct for calculations of storage volumes

†Truck loads contain 4,500 gallons PACl and 4,200 gallons alum per truck as quoted by Delta Chemical

Table 4.3

Comparison of amount of the PACl needed versus alum at Dalecarlia and McMillan using maximum dose from historical data

Dry alum	Coagulant	Neat PACl
1.330	Specific gravity	1.279
5.38	Coagulant density (lb/gal)	10.67
	Dalecarlia	
132	Design plant flow (mgd)*	132
47	Max coagulant dose (mg/L)	47
51,741	Coagulant dose (lb/day)	51,741
9,617	Amount of coagulant used (gal/day)	4,849
288,521	30 day storage (gallons)	145,477
69	Number of truck deliveries per month†	32
	McMillan	
74	Design plant flow (mgd)*	74
52	Max coagulant dose (mg/L)	52
32,092	Coagulant dose (lb/day)	32,092
5,965	Amount of coagulant used (gal/day)	3,008
178,953	30 day storage (gallons)	90,231
43	Number of truck deliveries per month†	20

*Provided by the Washington Aqueduct for calculations of storage volumes

†Truck loads contain 4,500 gallons PACl and 4,200 gallons alum per truck as quoted by Delta Chemical

EVALUATIONS OF EXISTING TANKS AND PUMPS

Dalecarlia WTP stores alum for its own use as well as for McMillan WTP (coagulant addition in Georgetown Reservoir). Nine 24,500-gal FRP tanks store alum on the top floor of the Chemical Building. These tanks that store the alum were built in 1999 and weigh 5,400 lb each. Alum is fed from the tanks to three 7.5-hp Gould's metering pumps where it is conveyed to the Parshall flumes at Dalecarlia WTP and the Georgetown conduit.

If the Washington Aqueduct chooses to switch from alum to PACl, then the present pump system capacity would be adequate. Based on one-time jar tests performed by EE&T, the volume necessary to store PACl would be about half that needed for alum.

The tanks have the total volume to contain 220,500 gallons of product. Based on average usage by Dalecarlia WTP (28,200 lb alum/day) and McMillan WTP (19,300 lb alum/day) the current alum storage capacity is 25 days. Table 15 shows a 30-day storage volume of 154,000 gal of PACl calculated from design flow (Dalecarlia – 132 mgd, McMillan – 74 mgd) and average dose (31 mg/L). This mans that, if stored in the existing tanks, the supply of PACl would last 43 days at design flow and average dose.

CHAPTER 5
ASSESSMENT AND RECOMMENDATIONS

When assessing the proposed change from chlorine gas to hypochlorite, a primary decision must be made before recommendations can be established: will the Washington Aqueduct purchase sodium hypochlorite in bulk and have it delivered to the plants, or will the Washington Aqueduct generate sodium hypochlorite on-site? Although there are significant economic and truck delivery differences between the two approaches, there are also major operational differences between these two options and the final decision must be made by the Washington Aqueduct prior to moving forward. Because both options are feasible, EE&T has prepared recommendations for each option. Recommendations were also made for the storing of caustic soda and acid while alum is used as the coagulant and recommendations were made for future considerations if a switch to polyaluminum chloride is made. Considerations are also given for operations during the construction transition to sodium hypochlorite for each of the alternatives recommended. Final layouts and economic analyses, including the 20-year present worth for recommended hypochlorite options, are presented.

DELIVERED BULK SODIUM HYPOCHLORITE

As discussed in Chapter 2, when purchasing commercially-manufactured sodium hypochlorite in bulk, the hypochlorite solution can be stored at 12 percent, the strength at what it is shipped, or it can be diluted and stored at a weaker concentration. For evaluation purposes, two strengths of sodium hypochlorite, 6 percent and 12 percent were considered when determining storage facility feasibility. The recommended storage options for storing delivered bulk sodium hypochlorite at either of the treatment plants are described in the following sections.

Please note that, while this feasibility study only developed costs for storing bulk sodium hypochlorite at either 6 percent or 12 percent, it is feasible to store sodium hypochlorite at any concentration less than or equal to 12 percent (generally it is difficult to have sodium hypochlorite delivered at concentrations greater than 12 percent due to degradation issues). Additionally, while this feasibility study has identified feasible layouts for each of the options considered, there are numerous alternate layouts that may also be feasible for these options.

Appendix B contains detailed cost estimates for the layouts considered in this study; if other layouts are to be considered, cost estimates for these layouts can be developed by modifying the unit quantities and unit costs shown in Appendix B accordingly.

McMillan WTP

As mentioned above, detailed capital cost estimates were prepared for each of the storage layout options discussed in Chapter 2, and are provided in Appendix B. Table 5.1 below summarizes the relative capital costs for storing bulk sodium hypochlorite at McMillan WTP. Unless stated otherwise, all costs presented in this chapter have been escalated to the midpoint of construction, which is estimated to be January 2009. An interest rate of 6 percent has been assumed for all cost escalations. Note that there may be a need for structural modifications in the slow sand filters; however the costs of those modifications cannot be accurately determined at this time.

Table 5.1

Escalated capital cost comparison for hypochlorite storage at McMillan

Option	Comparative capital cost (dollars)
12 percent – existing building (18-ft tank)	3,784,000
12 percent – new building (12-ft tank)	8,376,000
6 percent – new building (12-ft tank)	13,800,000
6 percent – new building (18-ft tank)	12,239,000
6 percent – sand filters (horizontal tanks)	16,405,000*

*Not including structural improvements

Based solely on the difference in capital costs, EE&T recommends that, if the Washington Aqueduct chooses to use purchased bulk sodium hypochlorite at McMillan, the sodium hypochlorite be stored at 12 percent strength inside tanks installed within the existing chloramine building. This option will fit within the existing structure, and the lower capital costs associated with utilizing the existing structure make this the most favorable option. The present worth of this option, compared to storing 6 percent or generating hypochlorite on-site, will be discussed later in this chapter. From an operational perspective, EE&T also recommends that the storage volume be generally maintained in the two week range as is the practice of other Virginia utilities. Tankage, however, has been provided for a full 30-day storage.

As discussed in Chapter 2, decomposition of the hypochlorite is easily managed through temperature control and inventory rotation. The addition of chlorate to the finished water is relatively minor under this scenario. The layout of the recommended bulk sodium hypochlorite option for McMillan is shown in Figure 5.1.

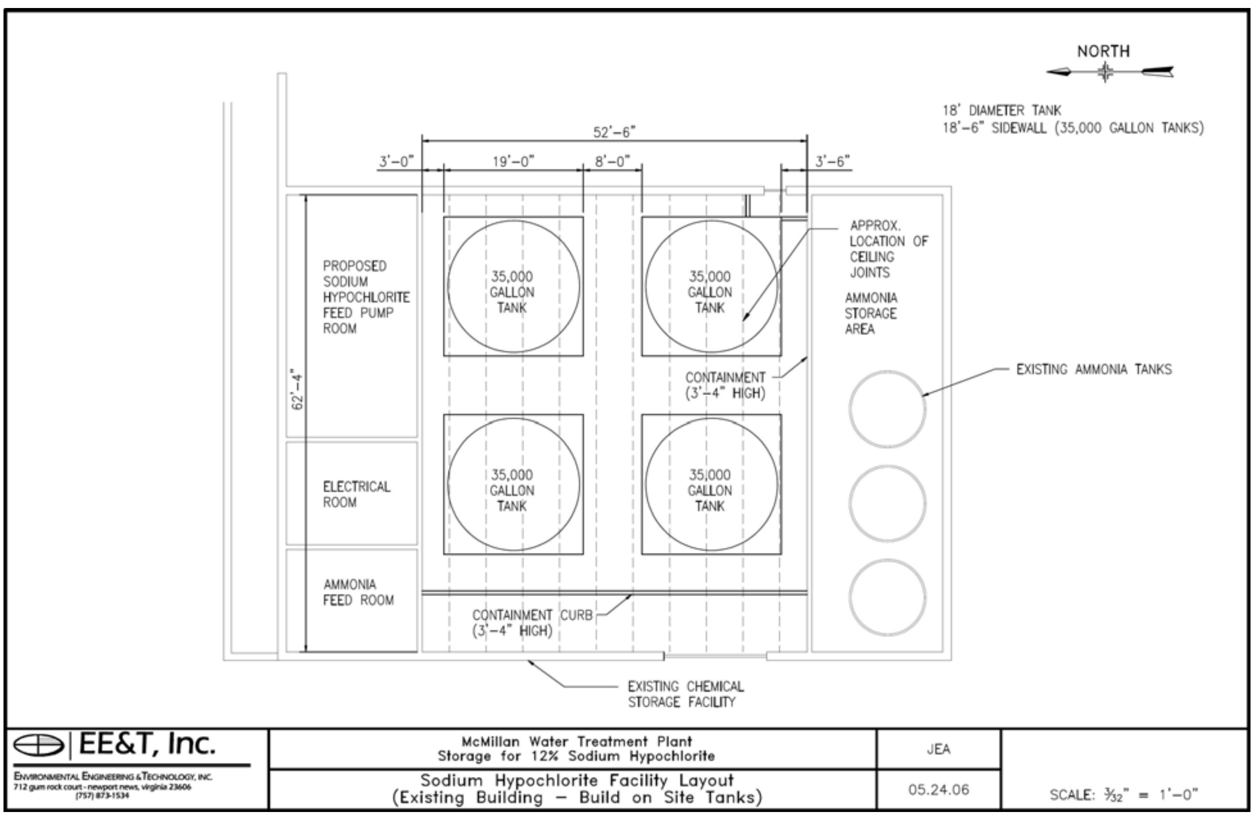


Figure 5.1 Recommended sodium hypochlorite option for McMillan

Transition Plan

Because McMillan has the option of feeding chlorine from the existing chlorine room or from the existing chloramine building, it is feasible to empty the chlorine tanks in the chloramine building while maintaining a chlorine feed for disinfection from the chlorine room. After the tanks have been emptied, they can be demolished and removed, which will open adequate space for installation of the sodium hypochlorite tanks and feed system. After the sodium hypochlorite system is active, the existing chlorine storage in the chlorine room can be removed and the space used for future needs.

In addition to the sodium hypochlorite storage and feed facilities, it will be necessary to have caustic soda and sulfuric acid feed systems operational prior to switching from chlorine gas to sodium hypochlorite disinfection. The transition plan for the construction of these systems is discussed later in this chapter.

Dalecarlia WTP

As with McMillan, detailed capital cost estimates were prepared for each of the storage layout options discussed in Chapter 2, and are provided in Appendix B. The budgeting cost estimates for each of the options are shown in below Table 5.2.

Table 5.2

Relative capital cost comparison for hypochlorite storage at Dalecarlia

Option	Comparison capital cost (dollars)
12 percent – new (12-ft tank)	12,282,000
12 percent – new (25-ft tank)	12,840,000
6 percent – new (12-ft tank)	21,692,000
6 percent – new (25-ft tank)	22,532,000

As discussed in Chapter 2, at Dalecarlia it was determined that constructing a new building to house the sodium hypochlorite storage would be the most suitable option for all four bulk sodium hypochlorite storage alternatives. This led to two majors factors that needed to be decided: whether to store 12 percent or 6 percent hypochlorite solution, and whether to use shop-built, 12-ft diameter tanks or field-built, 25-ft diameter tanks.

EE&T recommends that shop-built, fiberglass-reinforced plastic (FRP) tanks be used at Dalecarlia. As explained in Chapter 2, FRP tanks manufactured in a controlled environment tend to be more reliable than tanks assembled in the field because the curing process of the tank resins can be affected by the temperature and humidity. Furthermore, according to the manufacturers contacted by EE&T, the cost of field-built vessels typically runs 150 to 200 percent higher per gallon than shop-built tanks. Additionally, off the shelf tanks are readily available if damaged tanks must be replaced, whereas bringing in a construction team to rebuild a field-build vessel may be more difficult. For these reasons, shop-built tanks will reduce both upfront and long-term costs. As mentioned in Chapter 2, it may be possible to truck in larger tanks – perhaps up to 14-ft diameter with special permits. During the conceptual design phase the final tank diameters can be selected.

Storing 12 percent sodium hypochlorite requires one-half the storage volume required to store 6 percent sodium hypochlorite, resulting in substantial capital cost savings. On the other hand, because 12 percent hypochlorite must be maintained at a temperature of 20°C or less, there are differences in the operational costs between the two options. The present worth of this option, compared to storing 6 percent or generating hypochlorite on-site, will be discussed later in this chapter.

The feasibility of constructing a facility capable of storing either 12 percent or 6 percent sodium hypochlorite was also considered. Essentially, such a facility would be sized to store 12 percent hypochlorite, but would be capable of also diluting to 6 percent. However, there are few apparent advantages to providing this operational flexibility. One of the primary advantages to storing 12 percent sodium hypochlorite solution is that the additional capital costs and operational complexities associated with the dilution equipment are avoided. This advantage is lost if dilution equipment is provided. Then, if the hypochlorite is diluted to 6 percent, there would only be sufficient storage volume for 15 days storage. If the goal is to limit hypochlorite decomposition and chlorate formation, it would be more economical to continue to store the 12 percent solution and simply reduce the number of tanks that are kept full; by limiting the active storage volume in this manner the average hypochlorite retention time would decrease, reducing decomposition. For these reasons, EE&T does not recommend constructing facilities capable of storing both 12 percent and 6 percent hypochlorite (or some other diluted concentration).

Considering the factors discussed above, should the Washington Aqueduct use commercially manufactured sodium hypochlorite at Dalecarlia, EE&T recommends that the hypochlorite be stored at 12 percent. Figure 5.2 shows the layout, as seen in Chapter 2, EE&T recommends for bulk sodium hypochlorite storage. This option is recommended both because of the lower upfront costs and the decreased operational demands associated with storing hypochlorite at this concentration. Quality considerations are the same as discussed for McMillan.

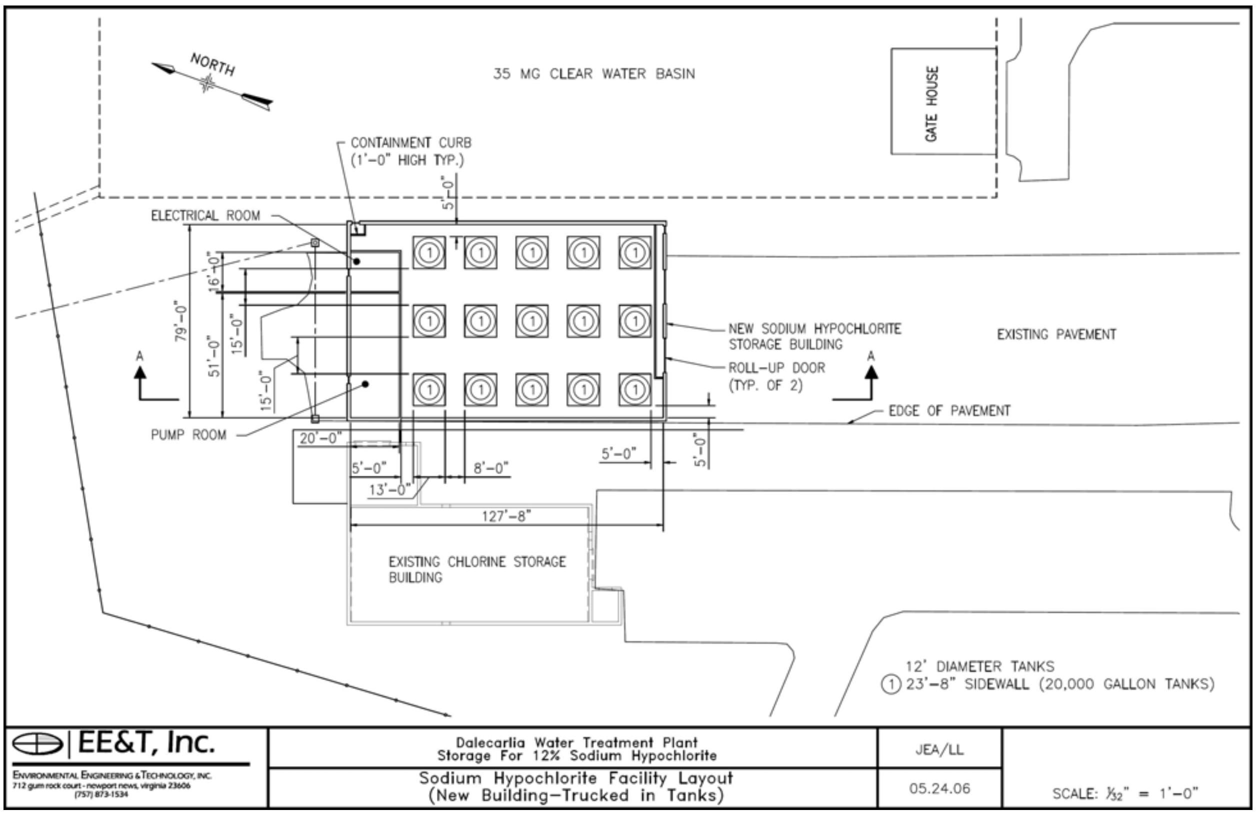


Figure 5.2 Recommended sodium hypochlorite option for Dalecarlia

Transition Plan

Because all of the sodium hypochlorite facilities are proposed to be located in a new building, the existing chlorine storage building can remain operational during construction. However, as with McMillan, it will be necessary to have a caustic soda feed system operational prior to switching from chlorine gas to sodium hypochlorite disinfection (acid is not needed). Additionally, it will be necessary to modify the existing lime feed system prior to startup of the sodium hypochlorite. The transition plan for the construction of these pH control systems is discussed later in this chapter.

ON-SITE HYPOCHLORITE GENERATION

As discussed in Chapter 2, the Washington Aqueduct may choose to generate sodium hypochlorite on-site at one or both of the treatment plants rather than purchasing bulk hypochlorite from commercial manufacturers. The recommended options for implanting on-site hypochlorite generation at either treatment plant are described below.

McMillan WTP

With proper design it is feasible for the on-site generation set-up to be placed in the chloramine building. This will allow the process to remain running through construction since disinfection will be delivered from the chlorine room. The recommended layout for the on-site generation equipment and tanks within the chloramines building is shown in Figure 5.3. This layout includes seven generators (one used for redundancy), each capable of producing 1,000 lb of chlorine per day, to meet McMillan's historical daily maximum usage of 5,350 lb of Cl_2. Because of the anticipated 4-mgd increase in flow, the maximum daily amount was thus set at 6,000 lb. This would make the design capable of achieving the historical maximum demand plus a 12 percent increase. Ancillary equipment (i.e. water softeners, filters, heaters, pumps, and monitoring equipment) are also included in the layout.

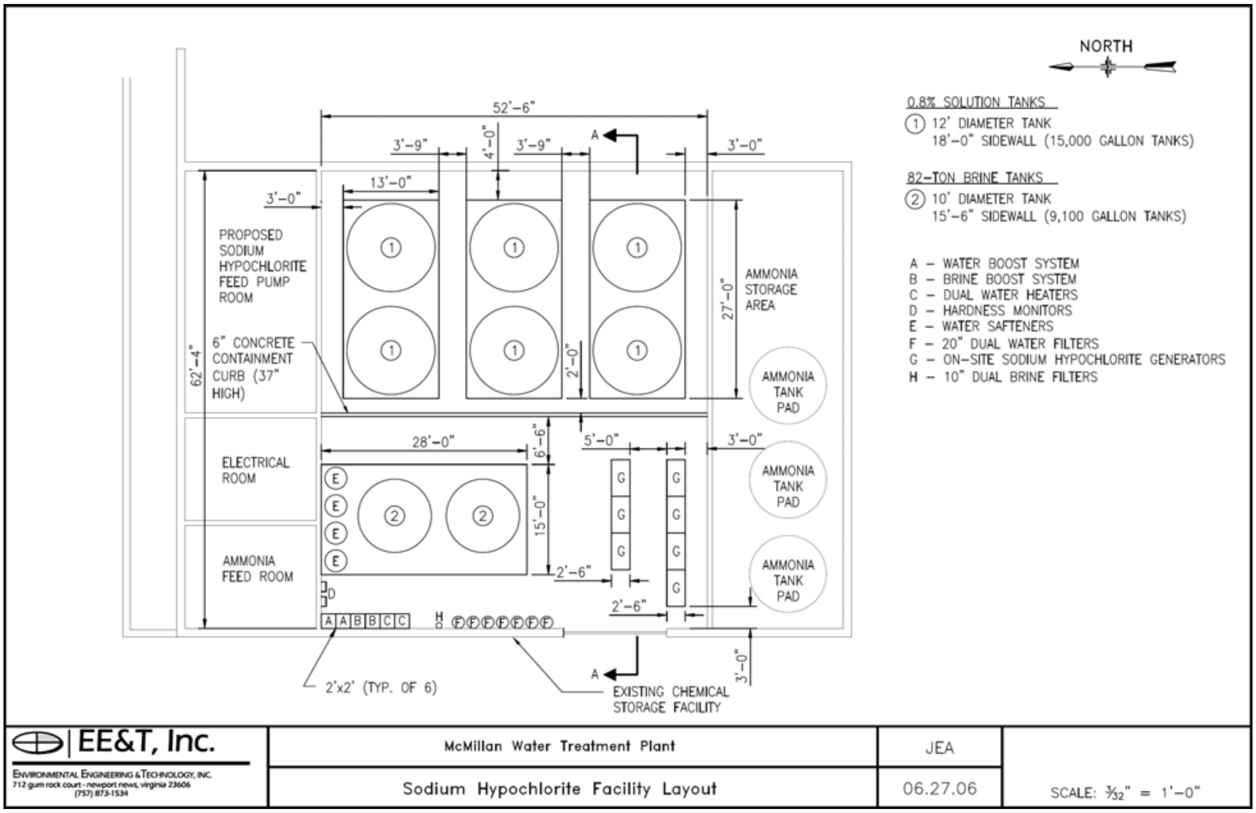


Figure 5.3 Recommended on-site generation of sodium hypochlorite option at McMillan

As described in Chapter 2, all tanks used in the design may be trucked in to avoid built in-place tanks; however due to lack of space, replacement tanks would need to be built in place. The brine tanks are designed for a month storage based on design flow of 74 mgd and an average chlorine dose of 5.8 mg/L corresponding to a daily usage of 3,582 lb of Cl_2 or 162 tons of salt a month (assuming 3.0-lb NaCl to produce 1.0-lb Cl_2). Each brine tank is capable of holding 82 tons or 1,217 ft^3 of salt, allowing a total storage capacity of 164 tons. The brine tanks have a 10-ft diameter and stand 15.5-ft tall, both on a 1-ft thick pad. To accommodate the 6,000-lb Cl_2 maximum, a day supply of the 0.8 percent hypochlorite solution would require 90,000 gallons of storage, which would be accomplished with six 15,000-gal, 12-ft dia., 18-ft high tanks.

The estimated costs associated with implementing the on-site generation are shown in detail in Appendix B. EE&T estimates that the capital cost of implementing this option will approach \$9.0 million. This includes the on-site generators, tanks, piping, and all associated equipment.

Transition Plan

McMillan has the ability to provide chlorine to the system from both the Chlorine Room and the Chloramine Building, which will allow a smooth transition for the plant and the contractor. If the Washington Aqueduct chooses to implement on-site hypochlorite generation at McMillan, then the Chlorine Room would be used during transition (i.e., demolition and reconstruction). This building has a capacity to feed 2,400 lb/day Cl_2 and store 36 tons of Cl_2.

As mentioned previously, it will be necessary to have caustic soda and sulfuric acid feed systems operational prior to switching from chlorine gas to sodium hypochlorite disinfection. The transition plan for the construction of these systems is discussed later in this chapter.

Dalecarlia WTP

As with bulk hypochlorite storage, at Dalecarlia it was determined the most feasible layout for on-site generation was to house the equipment and storage tanks in a new building. Should the Washington Aqueduct choose to use on-site hypochlorite generation at Dalecarlia, the recommended layout for the equipment is shown in Figure 5.4. This layout uses eleven sodium hypochlorite generators (one provided for redundancy) that are each capable of producing a maximum of 1,000 lb Cl_2 per day; this meets the historical maximum daily usage of 9,630 lb of Cl_2 at Dalecarlia WTP. The units can be juxtaposed and require 3-ft spacing from the wall and 5-ft clearance in the front. Adequate room is provided for operator movement and replacement of generators and ancillary equipment (i.e. water softeners, filters, heaters, pumps, and monitoring equipment). The ancillary equipment is arranged against the South wall of the new building bordering the present chlorine facility's North side.

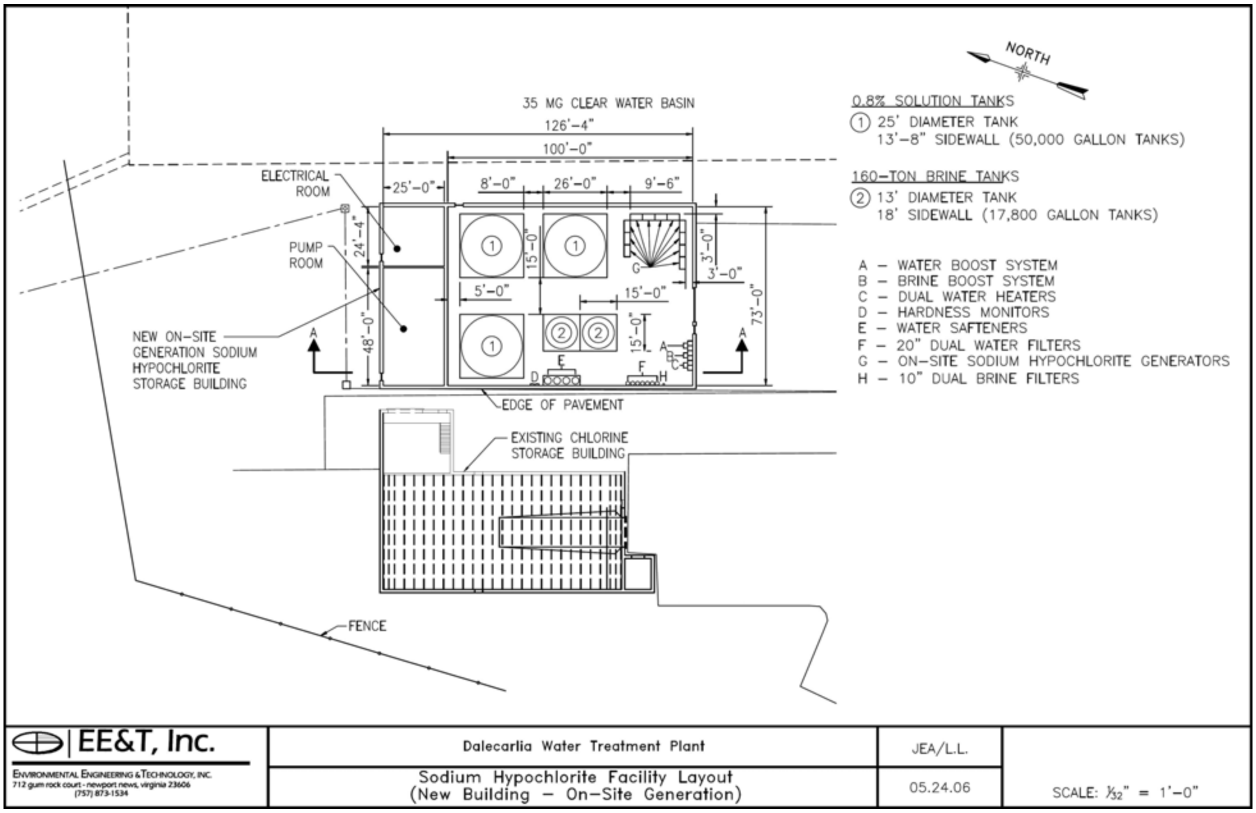


Figure 5.4 Recommended on-site generation of sodium hypochlorite option at Dalecarlia

With a design flow of 132 mgd and an average dose of 6.4 mg/L Cl_2, a month supply of salt would be about 635,000 lb NaCl (assuming 3.0 lb NaCl to produce 1.0 lb Cl_2). At a density of 135 lb/ft^3, the corresponding volume (4,700 ft^3) requires two 2,350-ft^3 tanks. The brine tanks (13-ft dia., and 18-ft high) sit on a common 1-ft thick pad with a surface of 15 ft by 30 ft. The two 160-ton brine tanks can be trucked-in instead of built in-place. The 10,000 lb Cl_2 maximum output of the generators would require 150,000 gallons of storage of the 0.8 percent hypochlorite solution for the recommended day supply, which is met with three 50,000-gal 25-ft dia., 14-ft high tanks.

The solution would be fed from the on-site building to the chemical building where the individual feed lines would be connected to the existing chlorine solution feed lines located in the chlorinator room. This allows some savings in construction costs and the same injection points presently being used to remain effective.

A detailed capital costs estimate for the construction of a new on-site hypochlorite generation facility at Dalecarlia is included in Appendix B. The capital cost of implementing this option is estimated to approach \$20.6 million.

Transition Plan

As with the bulk hypochlorite storage option, it is recommended that the on-site hypochlorite generation facilities be located in a new building. This enables the chlorine feed from the existing Chlorine Building to be maintained until construction of the new building is complete. Once the new building is constructed the existing chlorine building could be converted for caustic and/or sulfuric acid storage.

As mentioned previously, it will be necessary to have a caustic soda feed system operational prior to switching from chlorine gas to sodium hypochlorite disinfection. Additionally, it will be necessary to modify the existing lime delivery system prior to startup. The transition plan for the construction of these pH control systems is discussed later in this chapter.

Comparison of Delivered Bulk Hypochlorite and On-Site Hypochlorite Generation

EE&T performed a present worth analysis to allow financial comparison of the three recommended alternatives the Washington Aqueduct may consider. This analysis estimated the total cost for each of the options over a 20-year period. Capital, O&M, replacement, and present value costs are shown in Tables 5.3 and 5.4 for Dalecarlia and McMillan.

As discussed previously, capital costs were developed for all options discussed in Chapter 2; these capital cost estimates are included in Appendix B. The capital costs used to calculate the present value costs of the three options shown in Tables 5.3 and 5.4 are those associated with the recommended or least costly layouts for each option.

Operational costs provided in Tables 5.3 and 5.4 take into account labor hours needed for basic operations within the process, HVAC requirements, and chemical costs. These costs were first calculated in current dollars (February 2007 dollars) and then escalated to January 2009 dollars.

Table 5.3
Comparison of sodium hypochlorite alternatives for Dalecarlia by present value

Dalecarlia recommended alternatives	Capital	Yearly O&M		Present value replacement	Present value
		Operations	Maintenance		
12 percent NaOCl	$12,282,000	$2,094,000	$4,000	$315,000	$36,661,000
6 percent NaOCl	$21,692,000	$2,128,000	$13,000	$595,000	$46,844,000
On-site Generation	$20,696,000	$784,000	$30,000	$365,000	$30,398,000

Table 5.4
Comparison of sodium hypochlorite alternatives for McMillan by present value

McMillan recommended alternatives	Capital	Yearly O&M		Present value replacement	Present value
		Operations	Maintenance		
12 percent NaOCl	$3,784,000	$1,176,000	$4,000	$150,000	$17,469,000
6 percent NaOCl	$12,239,000	$1,201,000	$13,000	$281,000	$26,444,000
On-site Generation	$9,002,000	$443,000	$18,000	$253,000	$14,543,000

For the on-site generation and 12 percent hypochlorite storage scenarios, it was assumed that an operator would check on the system for an hour each day, and need an hour to assist/overlook each delivery. This time was doubled for the 6 percent option because of the increased amount of equipment that must be inspected. The time allocated for each delivery was also increased by 1 hour for the 6 percent option to account for the diluting process. A burdened wage of $41/hr was estimated for all labor costs.

HVAC costs were estimated by determining the full load energy requirement based on the size of the structure and the temperature set point, and multiplying this by an average of 2,430 equivalent full load hours. It was assumed that the 6 percent and on-site generation options would maintain HVAC for worker comfort. Overall, HVAC costs were minimal, ranging from a low of $2,000 annually (for the on-site option at McMillan) to a high of $12,000 annually (for the 12 percent option at Dalecarlia.)

Labor and HVAC costs comprise a small fraction (<5 percent) of the overall operations costs. The remainder consists of the cost to purchase/produce the sodium hypochlorite. All chemical costs were computed using the plant's average annual usage, which was calculated by multiplying the plant's average daily usage by the design flow rate. The prices used to determine the operations costs were \$0.91/gallon for 12 percent hypochlorite[6], \$0.05/lb of NaCl, and \$0.075/kWh for power.

For delivered bulk hypochlorite, the majority of the estimated maintenance costs are associated with operator labor. This includes an estimated requirement of 100 hours annually for repairs and up-keep for the 12 percent system; for the 6 percent system, this was increased to 300 hours annually because of the increase in equipment and maintenance requirements of the softening system. For on-site hypochlorite generation, maintenance costs were estimated using information from an existing plant utilizing on-site generation (the Ralph Brennan Water Treatment Plant in Daytona Beach, FL). Based on information provided by Severn Trent Services, the material costs at this plant for the on-site hypochlorite generation system (not including the cost of salt or power for hypochlorite generation) over a five year period averaged \$0.01 per pound of free active chlorine produced. These costs do not include replacement of major items, such as generator cells, but instead consist of consumables such as generator electrodes, acid solution for cell washing, and regeneration of water softeners. In addition to these material costs, labor requirements for maintenance were considered, including sixteen operator labor hours per year for generator up-keep (cell acid washing and filter cleaning/replacement) and 16 hours annually for tank cleaning. For all options, the estimated maintenance cost represents a small fraction (<4 percent) of the total annual operations and maintenance (O&M) cost.

In addition to the annual O&M costs, replacement costs were identified for major pieces of equipment that are expected to be replaced within 20 years. In conversations with representatives on hypochlorite equipment, average lifetimes were established for many of the major equipment items, including tanks, pumps and on-site generator cells. For the calculations, it was assumed all items would be replaced at the end of their design lifetime. Future costs for replacement were assumed to be the same as the current cost of that equipment since it is standard practice not to inflate costs in a present worth analysis. Table 5.5 details the design lifetime and current cost estimate for the major items included in the replacement cost estimates.

[6] Quoted by UNIVAR USA, Inc. as delivered price

Table 5.5

Design lifetimes and replacement costs for major equipment items

Alternative	Equipment	Percent to be replaced over design lifetime (percent)	Lifetime (years)	Cost per item (Feb 2007 $)
On-site Generation	Generator Cells	100	7	28,000
	Metering Pumps	10	10	20,000
12 and 6 Percent	Solution Tanks	100	15	28,000 - 70,000
	Metering Pumps	20	10	20,000

Present value costs were developed for each of the recommended alternatives, combining the estimated capital costs with the estimated operational and maintenance costs over 20 years and the escalated present value of the future costs for replacement items. An interest rate of 6 percent was used for all the present value cost projections.

pH CONTROL CHEMICALS

The pH control chemicals that will be used at the treatment plants are lime, caustic soda, and sulfuric acid. As discussed in Chapter 3, it is recommended that caustic soda be delivered and stored at a concentration of 25 percent to reduce operational problems associated with storing more concentrated caustic soda. EE&T also recommends that sulfuric acid be delivered and stored 93 percent as it is less corrosive at the higher concentration. The recommended pH control chemical storage strategies for both treatment plants are discussed below.

McMillan WTP

Following the switch to sodium hypochlorite disinfection the treated water pH at McMillan will be higher than it is currently, as is described in Chapter 3. This substantially reduces the amount of base needed to raise the pH to the finished water pH target; in fact, the treated water pH will sometimes be higher than the target, which will require sulfuric acid to be added to lower the pH. For this reason, EE&T recommends eliminating the existing lime feed system at McMillan and relying only on caustic soda for upward pH adjustment. As described in Chapter 3, the recommended caustic soda and sulfuric acid storage volumes for final pH trim are 24,000 gallons and 5,000 gallons, respectively.

There are many potential storage areas and layouts that would provide needed caustic soda and sulfuric acid storage. The existing lime room, underground slow-sand filters, and the chlorine room were all considered. Based on a cost analysis, locating the caustic soda and sulfuric acid storage facilities in the existing chlorine room is the preferred option. However, this will require that temporary caustic soda and sulfuric acid storage and feed facilities be provided during construction, as will be discussed further in the Transition Plan section. If the Washington Aqueduct decides that the use of temporary feed facilities is not feasible, it may be possible to use the slow-sand filters to house both the caustic soda and sulfuric acid storage tanks in order to avoid the need for temporary facilities. However, this will depend upon the structural feasibility of locating chemical tanks in the existing slow sand filters.

The existing chlorine room will need to remain active to provide disinfection during construction. Therefore, it will be necessary to have the sodium hypochlorite facilities constructed and on-line before the existing chlorine feed facilities are removed from the chlorine room to make space for the permanent caustic soda and sulfuric acid storage facilities.

A feasible layout for the permanent caustic soda and sulfuric acid storage facilities in the existing chlorine room is shown in Figure 5.5. EE&T is proposing that factory built, 7-ft diameter tanks be used to provide chemical storage. These 3,000 gallon tanks are small enough to fit through existing doorways in the chlorine room, which will avoid the need for structural modifications to the existing room to enable construction. The proposed layout provides sufficient free space to remove damaged tanks and bring in new tanks for replacement.

EE&T estimates that the total capital cost of this storage will approach $2.8 million. This is a discrete cost, independent of any associated costs for construction of the hypochlorite facilities. This cost includes $574,000 for the provision of temporary feed facilities. The cost provided for the temporary feed facilities is solely for labor and equipment rentals to operate the system; chemical costs were not included because they are operational costs.

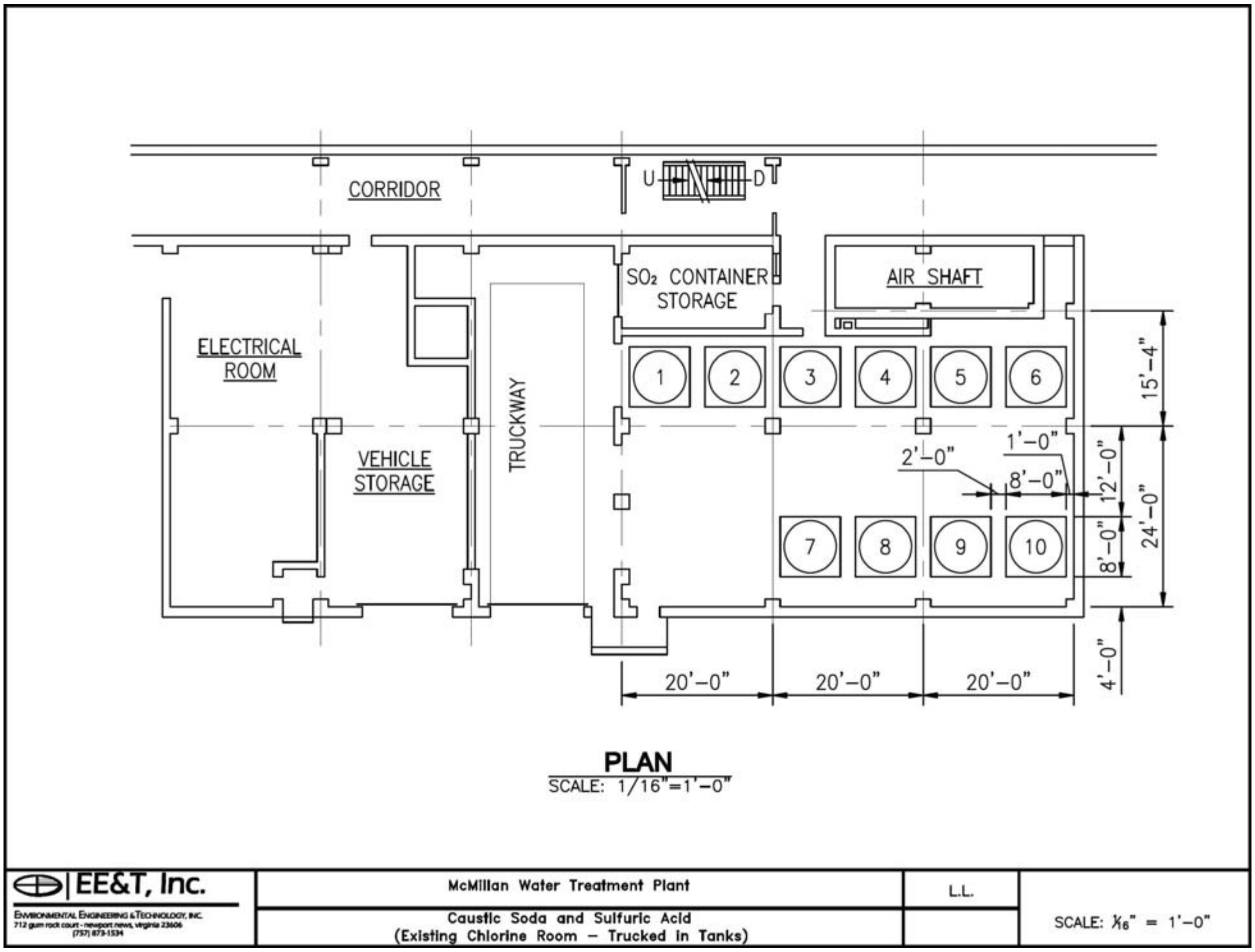


Figure 5.5 Recommended pH control chemical storage option at McMillan

Should the Washington Aqueduct choose to avoid the need for temporary caustic soda and sulfuric acid feed facilities during construction, it may be possible to locate the permanent facilities inside the slow sand filters; this would allow the permanent facilities to be constructed while the sodium hypochlorite facilities are constructed, so that the could be brought online together. Both filter no. 8 and filter no. 9 are substantially closer to the injection points where pH adjusting chemicals would be applied than any of the other filters. These filters' close proximity to the injection points decreases in the total length of feed piping needed compared to other possible areas. Though filter no. 9 is located closer to the injection point, this filter is currently the dumping area for lime removed from the clearwell floors. Therefore, filter no. 8 is the next best location for the caustic soda and sulfuric acid storage tanks.

Filter No. 8 is currently housing fuel in horizontal tanks situated in a similar fashion to the positioning EE&T is proposing for the caustic and acid tanks. The abandoned underground filter area has 22-in. wide columns every 14 ft (center to center) allowing approximately 12-ft openings between columns. EE&T is proposing using 3,000 gallon, 8-ft dia. horizontal tanks that can be oriented east to west like the fuel tanks presently stored in filter 8. The proposed layout is shown in Figure 5.6.

It will be possible to locate the caustic soda and sulfuric acid storage tanks in the same structure, although it will be necessary to separate the containment berms and venting manifolds. Depending on the condition of the filter roof, it may also be necessary to repair the roof or provide separate overhead protection for the tanks (this has not been included in cost estimating). Finally, winter temperatures inside of the slow-sand filters should be considered; if it is likely that the interior temperatures will drop below -5°C for extended periods of time, it may be necessary to insulate or heat the caustic soda tanks.

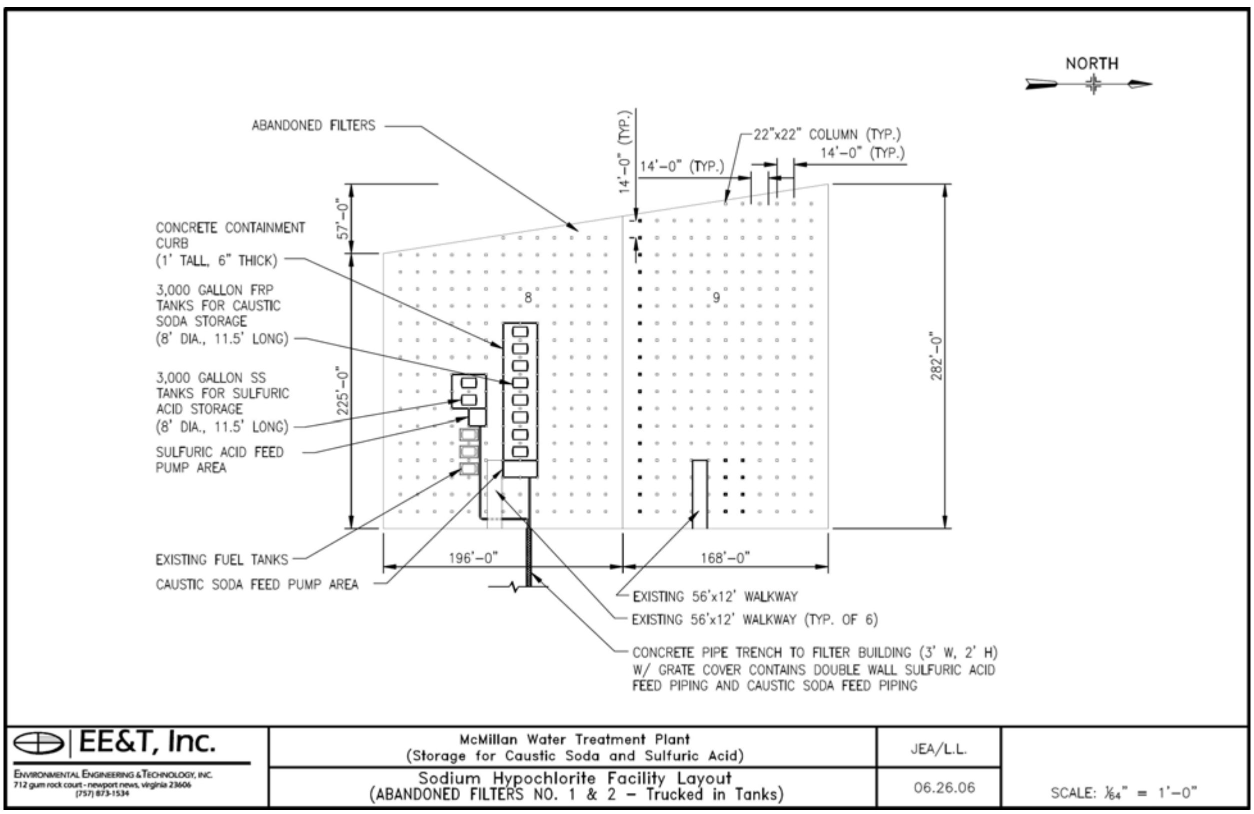


Figure 5.6 Alternative pH control chemical storage option at McMillan for elimination of temporary pH control chemical feed systems during construction

EE&T estimates that the total cost of this storage will approach $3.7 million. This is a discrete cost, independent of any associated costs for construction of the hypochlorite facilities. This cost estimate includes higher than normal labor rates, due to the working conditions inside the slow-sand filter. These costs do not include structural improvements. The above discussion assumes that the slow-sand filters are structurally sound to the extent that the storage tanks can be safely supported. A structural evaluation was not included in this study and this must be done prior to final selection of this option.

Transition Plan

As described previously, the existing lime feed system will not be able to adequately control the pH following the switch to hypochlorite disinfection; therefore, the caustic soda and sulfuric acid storage and feed systems must be operational prior to the changeover. Unfortunately, the chlorine room must remain operational during construction. Therefore, for the period of time after the sodium hypochlorite is brought on-line to the time that the chlorine room can be emptied and permanent caustic soda and sulfuric acid storage facilities can be constructed, it will be necessary to provide temporary storage and feed facilities for these two chemicals. After the permanent storage facilities are completed, the temporary facilities can be removed.

Some chemical distributors are capable of providing the needed temporary caustic soda and sulfuric acid storage and feed systems. These systems include double-walled tanks, located outside of the plant, along with metering pumps, and temporary piping. The costs for installing and removing the temporary chemical feed facilities, along with the daily charge for equipment rental, are included in the appropriate cost estimate in Appendix B.

If the caustic soda and sulfuric acid storage is located in Filter No. 8, the transition plan from chlorine gas to sodium hypochlorite will not be difficult; the new facilities can be constructed prior to switchover without impacting the current plant operations.

Dalecarlia WTP

As described above, it is recommended that any new sodium hypochlorite storage constructed at Dalecarlia be located inside a new building. This frees the present chlorine building to house the new caustic soda storage. This building could also house potential sulfuric acid storage facilities, although these would only be needed if the Washington Aqueduct implements PACl coagulation, and only then for raw water pH control. The recommended caustic soda storage layout is shown in Figure 5.7, along with the proposed sulfuric acid storage layout in the event the Washington Aqueduct chooses to implement PACl coagulation.

EE&T estimates that the total cost of constructing the needed caustic soda storage is $2.2 million. This is a discrete cost, independent of any associated costs for construction of the hypochlorite facilities. Costs for modification of the lime slakers are not included nor was the feasibility of modifying the slakers evaluated. If the Washington Aqueduct decides to implement PACl for coagulation, it is estimated an additional $1.0 million will be required to construct the required sulfuric acid storage and feed system. The cost estimates for these facilities are provided in detail in Appendix B.

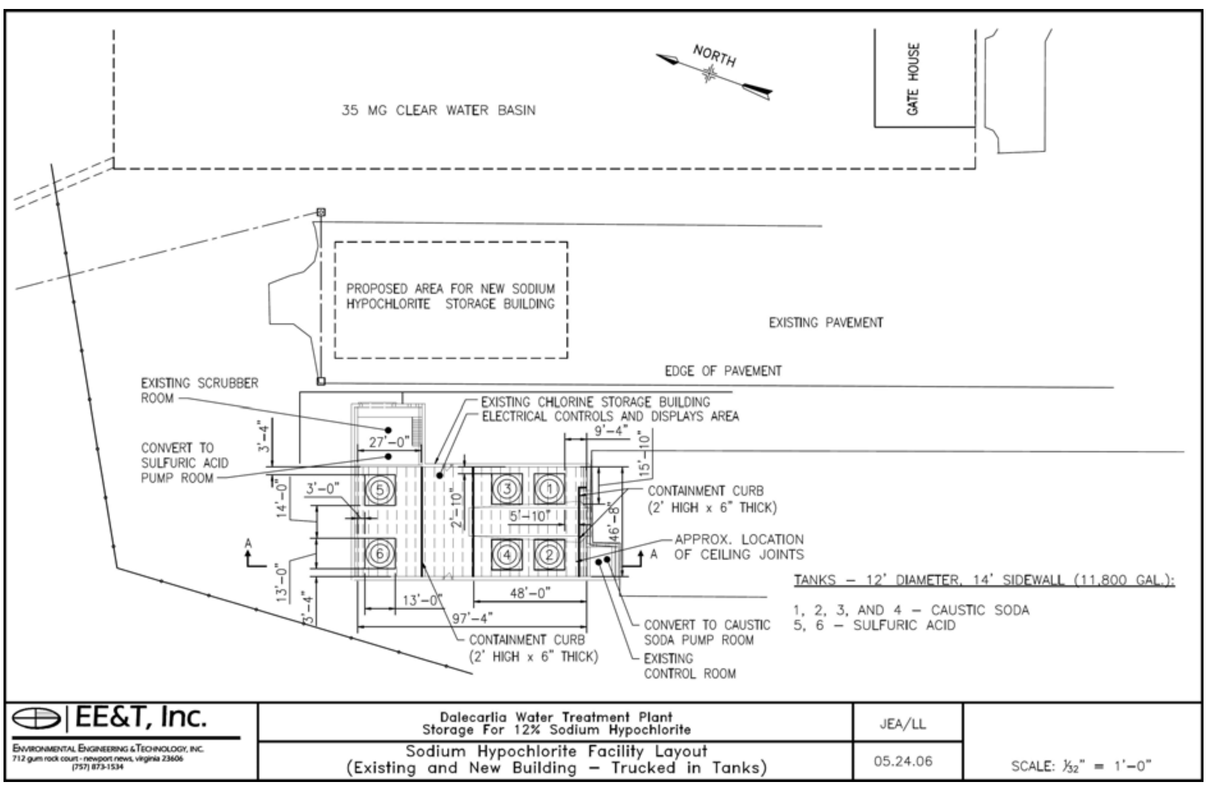


Figure 5.7 Recommended pH control chemical storage option at Dalecarlia

Transition Plan

As with McMillan, the existing lime feed system at Dalecarlia is not capable of accurately dosing lime at the levels needed to maintain the pH at the target value following the transition from chlorine gas to hypochlorite. Therefore, during the construction of the new hypochlorite building certain tasks would have to also occur to make the transition successful. The tasks are:

- Replace one of the lime slakers with a system capacity for feeding the low doses at the required accuracy, perhaps with a volumetric screw feeder or a loss-in-weight feeder. Due to the difficulty to slake lime at low throughputs, this may also require Dalecarlia to store and use hydrated lime as opposed to pebble lime. An investigation into the feasibility of accurately feeding the low levels of lime required was not part of this project and needs to be completed before proceeding. If feeding lime as required is not feasible, the caustic soda facilities will need to be enlarged.
- Caustic soda storage tanks would be installed in the present chlorine building during construction, along with the caustic soda feed piping from these tanks to the final feed points.

Essentially, it is necessary for Dalecarlia to have a portion of the final pH controls in place (though not necessarily at full capacity) prior to startup of the hypochlorite system. The first required action is replacement of one of the lime slakers (the other slaker will be needed to control pH until the chlorine gas disinfection is discontinued) with a device that can administer lime at lower doses. At their lower limit, the current slakers produce 200 lb CaO/hr, corresponding to a minimum lime dose of 5.8 mg/L as CaO (7.7 mg/L as $Ca(OH)_2$) when the plant is running at average flow (99 mgd). Dalecarlia may experience situations after the switch to sodium hypochlorite where the lime doses required to achieve a final pH of 7.4 could be as low as 0.8 mg/L as $Ca(OH)_2$. Based on the estimated lime doses used with the caustic trim it is possible that the Washington Aqueduct could replace the belt type slakers with either a volumetric screw feeder or a loss-in-weight feed system to dose the lime. Again, because it is unlikely that a slaker could be operated at as low a throughput as is required, it is likely that the pebble lime currently used will need to be replaced with a hydrated lime product in the new system (see discussion above).

At the same time the hypochlorite building is being constructed and one lime slaker is being replaced, the present chlorine building will need to be modified to allow for the installation of a portion of the caustic soda storage. Two caustic soda storage tanks will be constructed at the south end of existing chlorine storage building. This will require removing some of the existing storage racks currently used to store both full chlorine cylinders before they are moved to the north end for use and empty chlorine cylinders prior to their removal. Four cylinder racks will need to be removed to construct the caustic soda storage tanks; thus, the existing chlorine storage capacity during construction would be reduced by 16 cylinders. After the cylinders are moved from the south end of the building the empty area would be demolished for the incoming caustic tanks. The trucked in caustic tanks would be installed and positioned in the corners of the south end allowing enough room for chlorine truck deliveries through the truck door to remain constant. EE&T estimates after the first two tanks are installed, creating 23,600 gallons of caustic soda storage, there would be 16 to 22 days of supply based on estimates for caustic trimming doses. This would correspond to one caustic soda delivery every 3 to 4 days using the 25 percent commercial grade during the construction period.

The two caustic soda storage tanks must be completely operational prior to startup of the hypochlorite system. This requires that the feed piping, pumps and all other appurtenances associated with delivering the caustic soda to the system must be completed. The caustic feed piping using appropriate material will be set in boxed trenching to the determined feed points. It is recommended that all caustic soda feed piping from the existing chlorine storage building to the selected feed points be constructed at the same time to avoid duplication of effort.

Constructing the lime (if possible) and caustic soda feed systems described above will enable the Washington Aqueduct to maintain a finished water pH of 7.7 after the switch to hypochlorite disinfection. Once this switch has occurred it will be possible to replace the other lime slaker, as well as remove the remaining chlorine gas storage and feed equipment and constructed the remaining caustic soda storage tanks.

If the Washington Aqueduct prefers not to transition the existing chlorine building into caustic soda storage during construction of the new hypochlorite facility, then another feasible alternative would be to provide temporary feed systems to supply caustic soda after the transition to sodium hypochlorite, before the permanent caustic soda storage facilities are constructed inside of the existing chlorine building. This would involve installing temporary double-walled tanks outside of the plant, along with the necessary metering pumps and temporary feed piping to provide temporary service. The temporary caustic system required for Dalecarlia is estimated at $373,000, assuming they would be needed for six months. This alternative will slightly lower the capital cost of converting the existing chlorine building into the caustic soda building by removing the hazardous working conditions.

A summary of the capital costs for the two alternatives for Dalecarlia and McMillan is shown in Table 5.6.

Table 5.6

Relative capital cost comparison for caustic soda and sulfuric acid storage

	Capital costs (dollars)
McMillan	
Existing Chlorine Room used for storage	2,759,000†
Slow sand filters used for storage	3,704,000
Dalecarlia*	
Construction occurs in Chlorine Building while chlorine feed is active	2,272,000
Construction occurs in Chlorine Building only after chlorine feed is off-line	2,486,000†

*Does not include costs for sulfuric acid storage (for PACl coagulation) or for modifications to the existing lime feed system.
†Includes the cost of providing temporary sulfuric acid and/or caustic soda storage and feed systems.

In addition to the capital costs outlined above, the annual costs for the pH control chemicals will vary depending on the operating scenario that is utilized. Again, the four scenarios considered in this study are:

- Scenario A: Alum coagulation, lime adjustment to 7.4, caustic soda trim to 7.7
- Scenario B: Alum coagulation, caustic soda adjustment to 7.7
- Scenario C: PACl coagulation, lime adjustment to 7.4, caustic soda trim to 7.7
- Scenario D: PACl coagulation, caustic soda adjustment to 7.7

Using chemical costs of $0.113 per pound of caustic soda delivered and $0.080 per pound of sulfuric acid delivered, annual costs for each scenario were developed. These costs are summarized in Table 5.7 and 5.8 below.

Table 5.7

Caustic soda chemical costs for pH control

	Scenario	Caustic soda average dose (mg/L)	Yearly usage (lb NaOH/yr)	Annual costs ($/yr)
Dalecarlia	A	2.67	1,072,900	136,000
	B	6.31	2,535,500	320,000
	C	2.31	928,200	117,000
	D	2.50	1,004,600	127,000
McMillan w/pH Change	A	0.39	87,900	11,000
	B	0.43	96,900	12,000
	C	0.28	63,100	8,000
	D	0.28	63,100	8,000
McMillan w/o pH Change	A	1.96	441,500	56,000
	B	2.68	603,700	76,000
	C	2.61	587,900	74,000
	D	2.97	669,000	85,000

Table 5.8

Sulfuric acid chemical costs for pH control

	Scenario	Sulfuric acid average dose* (mg/L)	Yearly usage (lb H_2SO_4/yr)	Annual costs ($/yr)
Dalecarlia	A	0.00	0	0
	B	0.00	0	0
	C	3.87	1,555,000	139,000
	D	3.87	1,555,000	139,000
McMillan w/pH Change	A	0.66	148,700	11,900
	B	0.66	148,700	11,900
	C	3.96	892,000	80,000
	D	3.96	892,000	80,000
McMillan w/o pH Change	A	0.01	2,300	200
	B	0.01	2,300	200
	C	3.87	871,800	78,000
	D	3.87	871,800	78,000

*Includes requirement for both raw water pH control to 7.5 and final pH trim to 7.7

PACl

If the Washington Aqueduct does choose to implement PACl coagulation, the doses of pH control chemicals needed for finished water pH control will change. As mentioned above, this feasibility study assumes that sulfuric acid will be used to maintain a raw water pH at or below 7.5 if PACl is used for coagulation. It was assumed that the sulfuric acid and PACl required for McMillan would be dosed at Dalecarlia, similar to the arrangement under which alum is currently administered. However, it is unknown how the sulfuric acid addition may affect the characteristics of the reservoirs, or how seasonal variations may affect the new coagulation scheme. EE&T recommends that, should the Washington Aqueduct decide to implement PACl coagulation, a year-long pilot study be conducted to further investigate if the coagulation pH control for McMillan is better borne at McMillan rather than through the reservoirs. Other items to investigate in the pilot study include: best coagulation dose and pH for turbidity, TOC/DBP, aluminum, impact on residuals production, cost/benefit analysis; and corrosion impacts. Also, it is important to note that estimates for pH control chemicals were based on bench data collected only over a 6-week time period. Ideally, more seasonal information and perhaps even pilot data would be used for these predictions. For this reason, an attempt was made to be conservative and to provide flexibility in the storage and dose selections.

ABBREVIATIONS

Alum	Aluminum sulfate
CT	Contact time
DBP	Disinfection byproduct
DOC	Dissolved organic carbon
EPA	United States Environmental Protection Agency
FAC	Free available chlorine
FRP	Fiberglass reinforced plastic
FWA	Fairfax Water Authority
HAA	Halogenated acetic acid, refers to the five regulated HAA compounds
HDPE	High density polyethylene
HVAC	Heating, ventilating, and air-conditioning
kWh	Kilowatt hour
LCR	Lead and Copper Rule
MCL	Maximum contaminant level
NaCl	Sodium chloride (salt)
NaOCl	Sodium hypochlorite
NEPA	National Environmental Policy Act
O&M	Operations and maintenance
OSHA	Occupational Safety and Health Administration
PACl	Polyaluminum chloride
PVC	Polyvinyl chloride
PVDC	Polyvinylidene chloride
QA/QC	Quality assurance/quality control
RMP	Risk management plan
RTW	Rothberg, Tamburini & Winsor Model for Water Process and Corrosion Chemistry, Version 4.0
SDS	Simulated distribution system
TFE	Polytetrafluoroethylene (also known as Teflon®)
THM	Trihalomethane, refers to the four regulated THM compounds
TOC	Total organic carbon

UV_{254}	Absorbance of ultraviolet light at a wavelength of 254 nm
V	Volts
WSSC	Washington Suburban Sanitary Commission
WTP	Water treatment plant

APPENDIX A

LITERATURE REVIEW AND UTILITY INTERVIEWS

LITERATURE REVIEW

A. Effect of sodium hypochlorite vs. chlorine gas on pH

Use of sodium hypochlorite typically increases solution pH, while chlorine gas typically reduces pH (Boyette et al. 1993).

B. Optimal coagulation pH with alum and with polyaluminum chloride and method of pH adjustment for optimal polyaluminum chloride coagulation

Polyaluminum chloride (PACl) is a partially hydrolyzed aluminum chloride solution, and in some circumstances can provide stronger, denser, faster-settling flocs than alum (USACE 2001). PACl is also reported to have several other benefits compared to alum (aluminum sulfate), including improved turbidity, color, and total organic carbon (TOC) removal; increased filter run length; reduction in the amount of solids produced (since less coagulant can be used); and reduced need for pH adjustment and coagulant aids or filter aids. PACl chemistry is similar to that of alum, except that PACls contain highly-charged polymeric aluminum species in addition to aluminum hydroxides (Pernitsky 2004). PACl may be considered to have the general formula of $Al_n(OH)_mCl_{3n-m}$.

Acidic hydrolyzing metal coagulants, such as alum and PACl, undergo hydrolysis reactions when diluted in water that decrease the alkalinity of the solution and tend to decrease the pH (Letterman, et al., 1999). As such, both alum and PACl typically lower solution pH when added to a raw water (e.g., Phuu, 2006) through the production of hydrogen ions during hydrolysis. However, alum is a stronger acid than PACl, and thus its addition results in a greater decrease in solution pH than does addition of PACl. While theoretical calculations can be made to predict the effect of PACl or alum addition on solution pH (Letterman et al., 1999), it is best determined through laboratory development of titration curves showing the change in pH as various quantities of coagulant are added.

Depending on the raw water pH and alkalinity, addition of a base such as lime or caustic sometimes must be used to maintain the pH in an optimal range for alum coagulation. Furthermore, if sufficient alkalinity is not present upon addition of alum, sulfuric acid may be produced, resulting in a further reduction in pH and the necessity to add a base to raise the coagulation pH back up to optimal levels. As such, PACl typically requires less pH adjustment than alum, and since lower quantities are used it also results in lower solids production than does alum. Each 1 mg/L of alum used consumes 0.5 mg/L of alkalinity, and PACl has lesser effect on alkalinity when added to water than does alum (PADEP, n.d.). For PACl, alkalinity consumption is related to the basicity of the PACl, and higher basicity PACls will consume less alkalinity than low or medium basicity PACls (Pernitsky 2004).

Though the effective pH ranges for alum and PACl are similar (5.5 to 8.5 and 4.5 to 9.5, respectively), the optimal pH range for alum is narrower (6.5 to 7.5 (PADEP n.d.), with some reports of 5.5 to 6.5 (e.g., Davis and Cornwell 1998) than that for PACl (4.5 to 9.5; PADEP n.d.). Phuu (2006) also reports that PACl can work over a wider pH range than can alum, and can be used with pH between 6 and 9 and in some cases with pH between 5 and 10.

O'Melia et al. (1989) reported that polymeric aluminum chloride was particularly effective in the treatment of turbid waters, especially at low temperatures, but that alum performed better for humic waters and for waters with low turbidity. PACl is also more effective for coagulation of water where alkalinity is low. PACl is also more effective than alum for waters of low pH, as well as more effective at removing fulvic acids than alum, especially for waters with low levels of fulvic acids (Hundt and O'Melia 1988).

Pernitsky (2001) examined the use of alum, PACl, and other polyaluminum coagulants for five different water types and three solid-liquid separation processes (sedimentation, dissolved air flotation, and direct filtration). PACl is less acidic and less temperature-dependent than alum (PACl performs better than alum at low temperatures). For PACl, the pH of minimum solubility tended to increase with increasing solution basicity. Aluminum speciation analysis indicated that high basicity PACls contained the largest fraction of dissolved polymeric species in solution over the widest pH range. Pernitsky (2001) showed further that the selection of the appropriate coagulant for a particular water is dependent on the chemical characteristics of the coagulant, raw water characteristics, and the treatment process used. High basicity PACls were shown to be effective for all of the model waters tested, and PACls with added sulfate or silica were especially effective for sedimentation, yet the presence of sulfate was detrimental for direct filtration treatment. Guidelines were developed for selecting polyaluminum coagulants and for selecting doses based on water quality parameters, coagulant characteristics, and the solid-liquid separation treatment processes (Pernitsky 2001).

Pernitsky and Edzwald (2006) provide guidelines for the selection and use of alum and PACl coagulants in relation to raw water quality and treatment methods. The type of subsequent solids separation processes is also important in coagulant selection. They also observed that the concentration of natural organic matter (NOM) was the most important parameter affecting coagulant dose. For both alum and PACl, the overall solubility and the pH of minimum solubility increase as temperature decreases. Furthermore, for different PACls, the pH of minimum solubility has been observed to increase as the degree of PACl neutralization increases (i.e., with increasing degree of PACl basicity) Pernitsky and Edzwald 2006). The authors also investigated the comparative use of alum and various PACls on five raw waters of varying turbidity, TOC, and alkalinity.

Based on theoretical considerations and the results of the case studies, Pernitsky and Edzwald (2006) developed guidance for the selection of polyaluminum coagulants. Selection of coagulant type may be based on various parameters, including the ability to maximize particle and turbidity removal, maximize TOC and disinfection byproduct (DBP) removal, minimize residual coagulant in the treated water, minimize solids production, and minimize operating costs (Pernitsky and Edzwald 2006). They concluded that raw water turbidity and the amount and nature of the NOM present affect the required coagulant dose, but generally do not influence the type of coagulant that will be most effective. Instead, alkalinity and temperature were the most important raw water quality parameters to consider when selecting coagulant type. Raw water alkalinity, as it relates to the pH of the coagulation process, is important for coagulant selection, and PACl basicity should be matched to raw water alkalinity so that the coagulation pH is as close as possible to the minimum solubility of the coagulant (pH of 6.0 to 6.4 at 20 ºC, and pH 6.2 to 6.9 at 5 ºC; the lower end of those pH ranges correspond to alum, and the upper end to high-basicity PACls). High-basicity PACls were found to be especially suitable for water with low alkalinity. For high alkalinity water, low-basicity PACls or alum may require acid addition to achieve the optimum pH conditions for coagulation. In that case, high-basicity PACls may be preferred since their pH of minimum solubility is higher, and thus they may provide adequate treatment with less (or no) acid addition required. Cold temperatures adversely affect the sedimentation process, and as such selection of the optimal coagulant is important. Alum performance is more adversely affected by low temperatures than is PACl, and high basicity PACls are less affected by low temperatures than low basicity PACls.

C. Effect of polyaluminum chloride on pin hole leaks

Rushing (2002) claims that “there are no proven causes of pinhole leaks in residential plumbing, only hypotheses that are supported to varying degrees by scientific data, and some that are outright speculation. Pinhole leaks have never been produced in the laboratory under conditions that are scientifically reproducible.” Loganathan and Lee (2005) propose a model capable of replicating time-dependent failure rates to generate synthetic sequences of leak arrivals, and use optimality criterion to designate optimal replacement time of the plumbing system.

The Maryland Department of Housing and Community Development (2004) produced a comprehensive task force study on Pinhole Leaks in Copper Plumbing. One main case study they report is for the Washington Suburban Sanitary Commission (WSSC) which has collected thousands of reports of pinhole leaks from their customers. In response to increasing reports of pinhole leaks, WSSC launched an investigation into pinhole leaks in 2000. They formed a task force to study the issue, and several experts in the field were contracted to assist the investigation. In addition, WSSC started collected data from its customers who had experienced pinhole leaks. In response to this study, WSSC developed an outreach program with bill inserts and web page information on pinhole leaks, and also implemented a pilot study to use orthophosphates. Plumbers in the WSSC service area have reported less pinhole leaks since the introduction of orthophosphates by WSSC on November 12, 2003.

As part of that overall investigation, research studies by scientists at the Virginia Polytechnic Institute and State University concluded that a combination of higher pH, low organic matter, aluminum solids, and free chlorine in water produces pinhole leaks (Rushing and Edwards 2004; Marshall 2004; as cited by Maryland Department of Housing and Community Development 2004). In addition, it appeared that aluminum solids catalyzed the cathodic reaction between copper and chlorine. Evidence for this effect was observed in increased chlorine decay rates, increased non-uniform copper corrosion, and rising corrosion potentials during exposure. A third-party study funded by the Copper Development Association Inc. confirmed these findings (Reiber 2003; as cited by Maryland Department of Housing and Community Development 2004).

The Maryland task force determined that aluminum-bearing compounds are the most probable corrosive agents involved in the outbreak of corrosion episodes in Maryland. However, they did not determine that aluminum-bearing compounds are the sole agents involved in corrosion, and the source of the aluminum was not determined. Aluminum in treated water can come from a variety of sources, including from concrete distribution system pipes, cement mortar lining of cast iron pipes, residual aluminum coagulant from the treatment plant, and from the raw water (Maryland Department of Housing and Community Development 2004).

Although aluminum has been implicated as a possible causative factor in the formation of pinhole leaks in copper piping, during this review EE&T did not find literature that examined the difference between alum and PACl for the potential to help cause pinhole leaks. However, since PACl generally results in less aluminum carried over to the distribution system, it may accordingly contribute less than alum to the potential for formation of pinhole leaks.

It should be noted that other combinations of water chemistry may cause pitting corrosion and pinhole leaks in copper plumbing. For example, Rushing and Edwards (2004) note that "The synergistic interaction between aluminum and chlorine shown to occur in this work is of particular interest, and it would be worthwhile to see if other solids in water caused similar effects on copper." (Rushing and Edwards, 2004).

Another possible cause of pitting is chloramines (Maryland Department of Housing and Community Development 2004). Chloramines are a weaker oxidant then pure chlorine, but more persistent. The Maryland task force report further claims that "the current literature indicates that dissolved carbon dioxide and hydrogen sulfide, and metals such as manganese, aluminum, and iron are associated with pinhole leaks, but association is not necessarily causation" (Maryland Department of Housing and Community Development 2004).

The Maryland task force report concluded with the following basic recommendations for water suppliers related to pinhole leaks in copper piping (more details are included in the task force report):

1. Establish a method to collect information from their customers and from plumbers on pinholes leaks
2. Develop information to inform the consumer about identifying pinhole leaks
3. Monitor and participate in current and future research in order to be aware of industry changes that may positively affect the supply of their product to reduce pinhole leaks, but not compromise the quality and safety of their water
4. Consider the research recently completed by the industry regarding the addition of orthophosphates and other additives
5. Strive to minimize the aluminum in the processed water and to keep the pH below the EPA recommended maximum of 8.5.

D. Residual aluminum levels under polyaluminum chloride vs. alum

The use of aluminum coagulants can at times result in higher aluminum levels in the treated water than in the raw water (Srinivasan et al. 1999; Letterman and Driscoll 1994). Elevated residual aluminum levels may increase turbidity, interfere with disinfection, reduce the hydraulic capacity of the distribution system via deposition, and potentially may also have adverse health effects (Letterman and Driscoll 1994; Driscoll, Letterman, and Fitch 1987). A survey of US drinking water utilities showed that 40 to 50 percent of the plants had aluminum concentrations in treated water above the raw water levels (Miller et al., 1983; cited by Letterman and Driscoll, 1988). USEPA has set a secondary standard range of 50 to 200 μg/L aluminum in finished drinking water.

Residual aluminum consists of dissolved and particulate species, and the latter is relatively easily removed by efficient solid-liquid separation in clarifiers and filters. Dissolved aluminum species can include complexes with natural organic matter, fluoride, phosphate, sulfate, and hydroxyl ion (Srinivasan et al. 1999; Driscoll et al. 1987). The factors affecting the formation of these complexes are discussed by Driscoll et al. (1987). Aluminum-fluoride complexes are soluble and can increase residual aluminum concentrations, but since fluoride is typically added following filtration and pH adjustment to slightly alkaline values (e.g., pH of 7.5 to 7.7), hydroxyl ion out-competes fluoride for aluminum in this pH range and thus this should theoretically minimize the impact of fluoride on residual aluminum (Srinivasan et al. 1999).

Temperature, pH and turbidity of the water are important factors in aluminum solubility and thus also for determining residual Al. Aluminum is highly soluble in acidic (pH < 6) and alkaline (pH >8.5) conditions, and reaches a minimum in solubility near neutral pH (pH of 6 to 6.5). At lower temperatures (e.g., 4ºC), the pH of minimum solubility increases, resulting in alum coagulation and hence higher residual aluminum levels. Correlation between effluent turbidity and residual aluminum levels has also been reported (Srinivasan et al. 1999).

A survey of 91 US drinking water utilities that use alum suggested that high concentrations of residual aluminum can be minimized by effective removal of particulate matter, especially when the raw water contains elevated concentrations of total aluminum (Letterman and Driscoll 1988). Several of the operators surveyed suggested that pH control can be used to minimize residual Al, and others would be careful not to add too much alum or would use other coagulants to help keep residual aluminum levels down. In one case it was reported that lime used for pH adjustment following filtration contained significant quantities of aluminum that contributed to residual aluminum levels (Letterman and Driscoll 1988).

A study by Gabelich et al. (2004) that compared PACl and alum for conventional treatment prior to reverse osmosis showed that PACl results in lower levels of aluminum in the treated water than alum. They tested alum and PACl at ambient pH (pH 7.8 to 7.9) and also at suppressed pH (pH 6.7), and PACl outperformed alum regardless of pH. Alum coagulation resulted in 184 to 273 μg/L total aluminum residual in the treated water, and only by lowering the pH to 6.7 was the mean soluble aluminum residual under their goal of 50 μg/L for alum treatment. In contrast, the 50 μg/L residual aluminum goal was met for PACl at all levels of pH tested.

Driscoll et al. (1987) showed that for one water treatment plant the use of alum resulted in a five-fold increase in total aluminum concentration from the influent (~10 μg/L) to the filtered water (~49 μg/L). Approximately 11 percent of the influent aluminum (from the raw water and also alum addition) was not removed during treatment; this residual aluminum carried over to the distribution system. There was also a shift in the speciation of aluminum fractions due to water treatment. In this case, the treated water contained little particulate aluminum (~7 μg/L), and the rest was in the form of either inorganic monomeric aluminum (71 percent) or organic aluminum complexes (29 percent) (Driscoll et al. 1987). Driscoll et al. (1987) hypothesized that fluoridation and sulphuric acid addition, along with seasonal temperature variations, were responsible for the shift in aluminum speciation.

Letterman and Driscoll (1994) investigated means of controlling aluminum levels in filtered water at three full-scale treatment plants using alum or PACl. They showed that the amount and form of aluminum in filtered water depends on the pH of the coagulation process and on the efficiency with which particulate aluminum is removed by subsequent separation processes such as filtration. The plants where coagulation was performed in the pH range of 6.5 to 7.0 had generally lower soluble aluminum concentrations in the finished water (< 50 μg/L). In addition, when particulate aluminum was effectively removed, such as with a polymeric filter aid, total aluminum concentrations in the finished water were also relatively low (<100 μg/L). However, when particle removal was less effective (resulting in filtered water turbidity above 0.1 NTU), particulate aluminum levels were also relatively high (>200 μg/L). Letterman and Driscoll (1994) also developed a step-by-step procedure for diagnosing and controlling residual aluminum in filtered water, including procedures for identifying and characterizing the residual aluminum problem using an aluminum fractionation procedure. They focused on three main potential causes of high aluminum levels in filtered water, including inefficient removal of particulate aluminum by filtration, high pH and/or high temperature, and high amounts of aluminum in lime (or other additives) used after filtration. They note that soluble aluminum concentrations will be minimized when the pH after coagulant addition and before filtration is approximately 6.5.

E. Chloramines

Though the Washington Aqueduct did not specifically address chloramines as an area of concern, the following report from San Francisco Public Utilities provides an excellent review of the topic. For this reason, this report has been provided in its entirety.

Concerns about chloramine causing skin and eye irritations, rashes, eczema, burns after bath. Claims that chloramine is a known skin irritant.

<u>Review of Information from Water Utilities.</u> A review of the San Francisco Public Utilities (SFPUC) water quality customer complaints database for the time period 2002 - 2006 has not revealed any increased trends in customer complaints regarding water quality or general health due to chloramine. SFPUC Water Quality Bureau (WQB) typically receives and responds to approximately one customer complaint per day on average from the San Francisco Water System (SFWS) that require on-site inspector follow-up and this call volume did not change in the time period 2002 – 2006 in any water quality category. One exception was dirty water complaints, which decreased after chloramine conversion due to improved water quality maintenance practices implemented for chloramine conversion.

During the time period following the February 2004 switch to chloramine through 2006, the San Francisco Department of Public Health (SFDPH) Water Epidemiology program received a total of 44 calls related to chloramine. Eleven of these customer calls were related to skin conditions (excluding questionnaire discussed below). The majority of calls (75 percent of calls with identified area code) to SFDPH came from outside the City of San Francisco from various cities on the Peninsula (650 area code).

Skin complaints associated with municipal drinking water have been reported in medical literature (du Peloux, Menage & Greaves; 1995, Bircher, 1990). **However skin complaints asserting a relationship with chloramine disinfection have not been reported in the literature and by other utilities that use chloramine for distribution system disinfection.** The SFPUC contacted 20 utilities serving water disinfected with chloramine in their distribution system to tens of millions of customers as well as contacted industry experts in the U.S. and abroad. None of those contacted recalled skin irritation from chloramine as an issue that had been raised by their customers. **Although a utility can receive occasional customer complaints on skin irritation, none have been linked to chloramination.** Skin irritation is typically linked to soaps and detergents used, customers' sensitivity to various environmental conditions, and sometimes bacterial growth within household plumbing if the water temperature in the hot water heater is too low. There are no known reports in the water industry of skin irritation due to chloramine (AWWA, 2006). **Skin irritation complaints are sometimes raised in systems that use either free chlorine or chloramine for distribution system disinfection.** In SFPUC system, customer complaints typically temporarily increase following a publicized news broadcast related to water quality.

SFDPH and SFPUC continue to monitor reports of skin reactions to chloramine, but to date have not identified reliable evidence that the individual health symptoms being reported are associated with the exposure to chloramine in the bathing water. The SFDPH independent investigation of 17 citizens who receive SFPUC water concluded that the complaints described were heterogeneous, and many of the respondents had underlying or preexisting conditions that would offer plausible alternative explanations for their symptoms (Weintraub et al, 2006).

<u>Prevalence and Causes of Dermatitis Symptoms in General Population.</u> According to the National Health and Nutrition Examination Survey (CDC, 2003-2004), the prevalence of dermatitis among the general population aged 20-59 is 12.1 percent. Even if as many as 2,500 people (0.1 percent of customers served by SFPUC) developed new dermatitis symptoms as a result of chloramine, it would be extremely difficult to design a study that supported a causal association; a calculation reveals such a study would need to enroll approximately 142,000 people (that is, 71,000 people with new symptoms and 71,000 people without symptoms). Estimated cost of such study would be in the vicinity of $1 million. Currently, we estimate there are possibly a few dozen people who are complaining of new dermatitis symptoms; therefore **quantifying any association would be virtually impossible. The only design that would be valid and draw any conclusions about causality would be a national study.**

Some people who have skin symptoms report that the symptoms disappear when they stop using chloraminated water for bathing. However this type of evidence can not be relied upon to conclude that the chloramine is causing their symptoms. When people reduce the frequency or change the location that they bathe, or when they bathe using bottled water, they are not just changing the quality of the water they are using. They are also changing many other factors that may have been responsible for symptoms that they may believe were related only to the water. For example, the temperature, pH, alkalinity, mineral content, etc. of the water may be different, the types of cleaning products that are used in each location may differ, the types of soaps and lotions that the person is using may have changed, the length of time spent in the shower or bath may have been reduced, or other environmental allergens that were present in one location may not be present in the other. The American Academy of Dermatology (AAD, 2006) recommends reducing the duration, temperature and frequency of baths and showers to help people who experience dry skin, itchiness, and other problems with their skin.

Review of Information from the Internet Sources. **Statements regarding chloramine being a known skin irritant appear to be based on extrapolated information from various Internet websites pertaining to concentrated chemicals.** Any chemical, especially oxidants or disinfectants in concentrated form, may cause skin or respiratory tract irritation. These symptoms are reported by the Material Safety Data Sheets (MSDS) or other hazardous material datasheets to provide information about the acute exposure in a work setting. Examples of such Internet websites can be found at http://www.state.nj.us/health/eoh/rtkweb/rtkhsfs.htm. Although one may interpret information regarding skin irritation and other exposure hazards due to chloramine at http://www.state.nj.us/health/eoh/rtkweb/0359.pdf, the same website lists similar type information for all disinfectants approved for use in drinking water: e.g., sodium hypochlorite (i.e., chemical used to provide free chlorine residual), chlorine dioxide, and ozone. Please see http://www.state.nj.us/health/eoh/rtkweb/1707.pdf for sodium hypochlorite, http://www.state.nj.us/health/eoh/rtkweb/0368.pdf for chlorine dioxide, and http://www.state.nj.us/health/eoh/rtkweb/1451.pdf for ozone.

Information contained on MSDS sheets, which are easily available on the Internet should be interpreted with caution. The US Occupational Health and Safety Administration requires companies to provide an MSDS if they use a material in their workplace. The MSDS is aimed at protecting workers from acute exposure to concentrated chemicals, and has little relevance for drinking water consumers. In addition, there is very little oversight in the quality of data on MSDS and the mere existence of an MSDS does not imply high quality of information. In the SFPUC system, chloramine is generated on-site from chlorine and ammonia, therefore SFPUC does not need to have an MSDS for chloramine but does have the MSDS for chlorine and ammonia, as these are the materials that our staff work around. Customers have sometimes brought up an MSDS sheet for chloramine-T, which comes up in Internet searches for chloramine, as relevant to potable water systems. Chloramine-T is sold commercially, but it is an antiseptic with a different chemical formula of (sodium p-toluenesulfonchloramine), and it is not used for drinking water disinfection.

Concerns about chloramine causing nose, throat, lung irritations, shortness of breath, coughing. Buildup of fluid in lungs, pulmonary edema, death.

The concerns of chloramine being a respiratory irritant and other listed claims possibly stem from two sources: (1) misinterpretation of information from various Internet websites pertaining to concentrated chemicals (see discussion of skin irritation issues), and (2) assumption that one can be exposed to di- and tri-chloramine in their shower or bath. An example of such concerns is listed at http://www.chloramine.org/toxicshowersandbaths.htm.

Conditions Necessary for Formation of Dichloramine and Trichloramine. SFPUC maintains high water pH in the distribution system for corrosion control (target 8.6 to 9.4 depending on the water source), and a minimum of 8.2 is required by California Department of Health Services (CDHS). The pH is stable in the system and does not drift appreciably in spite of low alkalinity and low mineral content of SFPUC waters. SFPUC provides rigorous quality control to maintain chlorine to ammonia-nitrogen weight ratio of 4.7:1 at the point of chloramine (mono-chloramine) formation. This ratio may decrease slightly in the distribution system as chloramine demand is exerted during water transmission and storage. The conditions to form di-chloramine are: pH range of 4 to 6 (at 5:1 – 7.6:1 chlorine to ammonia weight ratios) or pH range 7 to 8 (at a 10:1 weight ratio) (Kirmeyer et al, 2004). The conditions to form tri-chloramine are at pH < 4.4 at weight ratios greater than 7.6:1 (Kirmeyer et al, 2004). **The conditions to form either di- or tri-chloramine do not exist in SFPUC distribution system.**

Both di- and tri-chloramine are short lived and even if trace amounts were formed, any of these chloramines would not persist to impact customers. Di-chloramine and tri-chloramine will not form as long as proper pH of the water is maintained above the range of di- and tri-chloramine formation, and as long as minimum free ammonia is present to maintain chlorine to ammonia weight ratio less than 5:1.

Some water systems have monitored water quality speciating for mono-, di-, and tri-chloramine; however, these monitoring programs were discontinued because di- and tri-chloramine was never found. Water quality labs at water utilities typically do not speciate chloramine but measure total chlorine.

Concern about Swimming Pools. Exposure to irritants is occasionally brought up in the context of public swimming pools. Di- and tri-chloramine may be present in swimming pools where chloramine needs to be converted back to free chlorine (1 – 3 mg/L free chlorine) to provide a stronger biocide necessary for water in contact with multiple bathers. **Pool water receives a great many nitrogen compounds in the form of perspiration and urine.** From these materials, urea is hydrolyzed to form ammonia compounds. Water in an improperly understood and poorly treated pool can lead to chlorine odors and stinging of the eyes. This condition is more easily observed at indoor pools and at the water surface in outdoor pools. The chlorine odor and eye stinging are often attributed to overchlorination. **In actuality, chlorine odor in pools is a symptom of inadequate chlorine addition and/or pH control.** The proper course of action is to increase the chlorine feed rate and chlorine dose, and to operate the pool in the free chlorine residual range. Pool odor is a classic example of improper treatment of water with chlorine and demonstrates a misunderstanding of the reactions of chlorine with ammonia compounds (Connell, 1997).

Concerns about chloramine causing buildup of fluid in lungs, pulmonary edema, death, blood in stool, pain, heart failure, blue-baby syndrome, weight loss, weight gain, hair loss, depression, oral lesions.

There is no evidence in the medical literature that links chloraminated drinking or bathing water to any of these health conditions. Lack of evidence does not necessarily imply that chloramine is not related to any of these conditions, however the likelihood of a relationship to these health conditions is minimal, principally because there is also no evidence that exposure to chloramine from drinking or bathing water is occurring in a way that people are not able to deal with physiologically. For example, when drinking water is ingested, chloramine gets broken down. The chloride is eliminated through the urine, and the ammonia is transformed to urea in the urea cycle. There is also no evidence that chloramine would be absorbed to the bloodstream through the skin, as such, there have been no published studies on the absorption of chloramine through the skin, in either animals or humans (EPA 1994). There is no evidence that chloramine volatilizes in the shower. There is always the possibility that individuals have specific hypersensitivities to chemicals in their environment, however there is no evidence that any of these alleged health effects occurs on the population level. People with individual health problems need to discuss treatment alternatives with their doctors.

There is no evidence that people who are on dialysis would have any special problems drinking or bathing in chloraminated water. Dialysis units need to remove chloramine because (1) in this situation the chloramine may diffuse across the reverse osmosis membrane and come directly in contact with the bloodstream and (2) patients are exposed to between 90 and 192 liters of water in each dialysis treatment (Amato, 2005).

Concerns about chloramine toxicity and the lack of tests

Three different kinds of evidence are available with regard to the potential adverse effects of chloramine in drinking water: (1) information from animal testing; (2) information from feeding studies in humans; and (3) information from epidemiologic studies. The Integrated Risk Information System (IRIS) provides a summary of the EPA's risk assessment of chloramine. The summary includes information on oral toxicity, chronic exposure and carcinogenicity of chloramine, based on human and animal studies. IRIS was updated with a comprehensive literature review in 2005, which determined that no new information is available to reconsider the conclusions made regarding reference doses or possible carcinogenicity (EPA 1992).

US EPA imposes a maximum residual disinfectant levels for chlorine and chloramine at 4 mg/L and for chlorine dioxide at 0.8 mg/L. **None of the disinfectants have been found to produce cancer. The toxicological effects of disinfectants (e.g., chlorine and chloramine) are nonspecific and occur at concentrations well above the suggested use levels.** More specific effects appear to be associated with hypochlorite solutions, chlorine dioxide, and iodine with respect to effects on thyroid function. Only in the case of iodine does this seem to limit its long-term use in the disinfection of municipal drinking water (Bull et al, 2001).

Animal Studies. Numerous animal studies have been done on the toxicity of chloramine (EPA 1992, USDHHS 1992). In general, these studies have not shown any likely effects on humans at the 4 ppm dose of chloramine that is used in drinking water. The oral reference dose for chloramine of 0.1 mg/kg/day is based principally on the National Toxicology Program studies in rats and mice that were published in 1992 (US DHHS 1992). The rat studies found "no clinical changes attributable to consumption of chloraminated water" and "no non-neoplastic lesions after the 2-year treatment with chloraminated water." The mouse studies had similar results (EPA 1992). Information on the absorption of chloramine is limited. In one rat study it was determined that about half of a single oral dose of chloramine was absorbed after 2.5 hours. However, there are no animal or human studies documenting absorption rates with respect to various dosage media and different routes of exposure (EPA 1994).

Studies in rats show that ingesting water containing chloramine does not affect white blood cell or red blood cell counts in any clinically significant manner (Moore 1980, as described in UNEP 2000).

Human Studies. There is evidence from human feeding studies that chloramine in the concentrations that are present in drinking water does not have any effect on human metabolism. A small study conducted in 1993 and published in the Journal Environmental Health Perspectives showed no effect of monochloramine ingestion at levels of 2 ppm. Healthy men were randomized to consume 1.5 liter per day of either distilled water, water containing 2 ppm monochloramine, or water containing 15 ppm monochloramine for four weeks. At the end of the study, the men who were drinking 2 ppm monochloramine, showed no difference in total cholesterol, triglycerides, HDL cholesterol, LDL cholesterol, apolipoproteins A1, A2, or B, compared to the men drinking distilled water. The 2 ppm study group had no difference in thyroid metabolism compared to the distilled water group. The men who drank 15 ppm monochloramine had no differences except that their plasma apolipoprotein B levels, (a protein associated with LDL cholesterol) had risen by about 10 percent, whereas the men drinking distilled water and the men drinking water with 2 ppm monochloramine had their plasma apoliporotein B levels drop slightly. The authors suggested that this finding may be due to chance, and should be confirmed in other studies (Wones 1993).

An additional study in humans was published in 1991. This study found that 10 healthy male volunteers experienced no different biochemical or physiochemical responses after drinking water treated with monochloramine at concentrations up to 24 mg/l in compared to a control group drinking untreated water (Lubbers 1991).

Epidemiological Studies. Epidemiologic studies compare health outcomes in populations or individuals drinking chloraminated water to those drinking other types of water (e.g. chlorinated, or not disinfected at all). A study by Zierler et al (1986) found a slightly increased mortality due to pneumonia and influenza in chloraminated cities versus those that use chlorine. These results have never been replicated, and alternative explanations for these findings are well discussed in the manuscript. These alternative explanations include a suggestion that differences in reporting or recording deaths could have led to these results, and that other differences such as smoking, occupational exposures, or other environmental differences could have explained the finding.

Several epidemiologic studies have shown reduced risk of nosocomial Legionnaires' disease in hospitals that use chloramine for disinfection compared to those that did not (Kool et al, 1999; Heffelfinger et al, 2003). A recent study in the San Francisco water system showed that Legionella species were virtually eliminated after chloramine was introduced in 2004 (Flannery et al 2006).

A 1988 study showed reduced risk of bladder cancer among populations using chloraminated waters compared to those that used chlorine for residual disinfection (Zierler et al, 1988). **This finding likely reflects the reduced exposure to disinfection by-products in chloraminated water.**

Disinfection By-Products of Chlorine and Chloramine. The interaction between chlorine and organic material in drinking water sources produces a wide range of chemical disinfection by-products (DBPs) of potential health concern, including trihalomethanes (THMs), haloacetic acids (HAAs), and other halogenated and non-halogenated compounds. **In general, chloramine forms halogenated by-products to a considerably lower extent than free chlorine, benefit of a "weaker" disinfectant.** Formation of DBPs similar to those observed in chlorination is expected, but at much lower concentrations (Speitel et al., 2004; Baribeau et al., 2006). Typically, HAA formation during chloramination is 5 to 20 percent of that observed with chlorination (Speitel et al., 2004), and no THMs are formed. Therefore, chloramination improves public health protection by minimizing the formation of regulated THMs and HAAs. SFPUC made the decision to convert to chloramine disinfectant in the distribution system to maintain compliance with the federal drinking water regulations. As a result, the levels of THMs were reduced in SFPUC system by about 50 percent and high THM and HAA peaks were eliminated.

Considering natural waters Total Organic Halides (TOX) production with chloramine ranges from 10 to 20 percent of that observed with chlorine, when chlorine and ammonia are added concurrently (Singer, 1999). At least some of halogenated products are different than those found from chlorination. Overall, DBP formation from chloramination can be minimized by maintaining the distribution system pH as high as practical (Singer, 1999), something that SFPUC has done continually.

Chloramine is a weaker oxidant than chlorine, and has greater tendency to participate in chlorine substitution reactions, rather than oxidation reactions, in comparison with chlorine. Substitution reactions are especially prevalent with organic nitrogen compounds (Singer, 1999). **Chloramine chemistry is fairly well understood. The complexities of chloramine chemistry with respect to DBP formation are not fully understood; however, considerable information is available** (Singer, 1999).

Cyanogen chloride has been associated with the use of chloramine. However, it will be formed in the presence of any combination of a strong oxidant, ammonia, aromatic amino acids, and chloride. Cyanogen chloride is primarily known as a respiratory irritant. Such effects occur at concentrations of cyanogen chloride in the air above 0.75 mg/m^3. The small concentrations produced in water treatment would be unlikely to produce these levels in air even in enclosed places such as a shower. The concentrations of cyanogen chloride in drinking water do not approach levels necessary to produce thyroid effects (Bull et al, 2001). Cyanogen chloride is currently unregulated, but probable regulatory range for cyanogen chloride was estimated at 60 to 600 ug/L.

In a survey of 35 utilities, the systems that prechlorinated and postammoniated had a cyanogen chloride median of 2.2 ug/L. The concentrations ranged from 1 to 11 ug/L (Krasner et al, 1989). Krasner et al (1989) also found that certain DBPs (i.e., haloacetonitriles, haloketones, chloral hydrate, and cyanogen chloride) were not stable in the distribution system where the pH is relatively high (e.g., pH 9) (Singer 1999). Therefore, **cyanogen chloride is of no significant concern to SFPUC**.

<u>Epidemiological and Toxicological Effects of DBPs.</u> There is substantial epidemiological evidence of the potential health effects of DBPs in human populations. Consumption of water containing these byproducts has been associated with cancer (Doyle et al, 1997; Bull et al, 1995; Morris et al, 1992) and adverse reproductive outcomes (King et al, 2000; Nieuwenhuijsen et al 2000; Gallagher et al, 1998; Reif et al, 1996; Savitz et al, 1995; Bove et al, 1995; Aschengrau et al, 1993; Fenster et al, 1992; Kramer et al, 1992; Zierler et al, 1992), although some of these studies have not found significant associations with specific outcomes.

Several epidemiologic studies have specifically explored the relationship between THMs and spontaneous abortions. (Waller et al, 1998; Swan et al, 1998) More recently a large study did not find an association between THMs exposure and pregnancy loss in three study sites, two of which used chloramination (Savitz et al, 2005). We are not aware of any other studies linking chloramination or specific chloramination byproducts to this health outcome. **Chloramination is very effective in controlling THM and HAA formation.**

It is important to note that no individual DBP has unequivocally been shown to be carcinogenic in humans in both epidemiological and toxicological studies. The strength of evidence from experimental animals that indicts DBPs as likely human carcinogens varies considerably. This remains a crucial scientific problem for judging the risk from DBPs (Bull et al, 2001). **Chloramine better controls the formation of regulated DBPs than chlorine.**

Discussion of Emerging Disinfection By-Products of Chlorine and Chloramine. The research community has been focusing on new classes of disinfection by-products that have been recently detected in drinking waters thanks to the advances in analytical technology and the surveys of chlorinated and chloraminated water systems. Specifically, nitrosoamines, iodo-DBPs, and hydrazine are discussed.

Nitrosoamines. Nitrosoamines, and the related nitrosamides including the nitrosoureas, are carcinogens that have been recognized as environmental contaminants of potential importance since the 1960s. These compounds have been most closely associated with the use of nitrite salts in food preservation. Active compounds in this class appear to induce tumors in virtually all species in which testing has been conducted (Bull et al., 2001).

Both chlorination and chloramination have been implicated in reaction mechanisms that result in N-nitrosodimethylamine (NDMA) formation from natural precursors. Furthermore, **field observations do not indicate that one method of disinfection leads necessarily to lower NDMA formation and therefore should be preferred** (Valentine et al., 2005). A recent national survey of NDMA occurrence and formation detected NDMA in 18 of 21 utilities surveyed disinfected with either chlorine or chloramine. The use of chloramine in the distribution system correlated with slightly higher NDMA levels than the use of free chlorine: the median for treated drinking water distribution samples was less than 2 ng/L for chloraminated water and less than 1 ng/L for chlorinated water (Valentine et al., 2005). Baribeau et al (2006) investigated formation of DBPs in chlorinated and chloraminated systems. There were no obvious differences between the concentrations of NDMA measured in free chlorinated and chloraminated systems. No particular trend in NDMA concentrations could be identified with increasing water age in a chloraminated system or a free chlorinated system. SFPUC has monitored for NDMA, an unregulated DBP, in the source water, plant effluents and in the distribution system before and after chloramine conversion on a quarterly basis. **Based on this significant dataset, NDMA has been below the level of detection of 2 ng/L (parts per trillion) in the vast majority of collected samples.** Occasional samples with detected NDMA were collected when the system was both free chlorinated and chloraminated. The highest measurement was 4 ng/L in a single sample, which is significantly below the California Department of Health Services (CDHS) Notification Level of 10 ng/L. There are no State or federal drinking water regulations for NDMA. **Chloramination has not resulted in increased NDMA levels and NDMA is not an issue for SFPUC based on available data.**

Iodo-DBPs. Iodo-DBPs are a new group of disinfection by-products that have recently been investigated. **The SFPUC system is unlikely to have significant levels of iodoacids because of the low concentrations of bromide (and likely iodide) in the raw water.** The only documented occurrence of iodoacids has been at one utility (Weinberg et al., 2002; and Plewa et al., 2004) with raw water bromide/iodide concentrations 10 times greater than that measured in SFPUC raw water. All waters treated by the SFPUC are free chlorinated prior to ammonia addition and chloramine formation, which will further preclude or minimize the formation of iodoacids. **SFPUC has taken part earlier in 2006 in the USEPA iodo-DBPs occurrence study and the results are forthcoming.**

The formation of iodinated compounds by chloramine treatment, in certain situations, is not unexpected. However, the level of toxicity associated with iodinated DBPs is only now being investigated and, at this point, it is not well understood. For years scientists have known that all chemical disinfectants will result in the formation of DBPs at some level. More than 500 disinfection by-products have been reported in the literature for the major chemical disinfectants currently used (chlorine, ozone, chlorine dioxide, chloramine), as well as their combinations (Weinberg et al., 2002). The formation of iodinated DBPs is recognized as an important research finding knowing that iodide is present in drinking water supplies throughout the world; for example iodinated THMs have been found in the United States (Weinberg et al., 2002), Australia (Hansson et al., 1987), France (Bruchet et al., 1989), and Spain (Richardson, 2004).

In 2002, the Environmental Protection Agency conducted a nationwide DBP occurrence study (Weinberg et al., 2002). This study also evaluated the occurrence of six iodinated THMs and was also the first to demonstrate the formation of iodinated acids. Iodoacids were detected at one utility that treats high-bromide water and uses chloramine both for initial disinfection and for maintaining a residual disinfectant in the distribution system. Plewa et al. (2004) postulated that chloraminated drinking waters that have high bromide and iodide source waters might contain these iodoacids and other iodo-DBPs. The study by these researchers (Plewa et al., 2004) observed that one of these acids (iodoacetic acid) was more genotoxic to mammalian cells than other DBPs that have been studied in their assay. One of the benefits of chloramine disinfection is that chloramination typically results in lower formation of brominated and chlorinated acetic acids and THMs as compared with chlorine.

These important research findings are not of immediate public health concern for the following reasons: (1) iodoacids have been detected only in one water system with high bromide and likely high iodide content (iodide is not commonly measured while bromide occurrence database is well developed), (2) iodoacids were detected at a utility that applied chloramine only and it is believed that the use of free chlorine before applying chloramine (as the SFPUC does) will allow the chlorine to react with iodide to form iodate and stop iodoacids formation (Plewa et al., 2004, Richardson, 2004). Iodate is not a health concern as it is transformed back to iodide after ingestion (von Gunten, 2003). The study of iodoacids toxicity by Plewa et al. (2004) used in-vitro isolated mammalian cells and not in-vivo animal or human subjects. This testing approach is typically used as a screening tool to determine candidate chemicals for future in-vivo toxicity testing.

Iodide occurrence in drinking water sources and its influence on the formation of iodinated DBPs are currently not known; a study to evaluate these has been proposed (AwwaRF, 2000). Methods for quantification of iodoacids are currently under development by the EPA (Richardson, 2004) and any further studies depend on our ability to measure concentrations of these compounds at the levels of potential concern. Further toxicological studies are warranted as stated by Plewa et al. (2004). SFPUC has participated in the US EPA iodo-DBPs occurrence study and will have the results of sampling its water in the near future.

Hydrazine. Najm et al. (2006) evaluated the formation of hydrazine as chloramine by-product. This is the first known study on the subject in drinking water. The project team found that "In laboratory experiment performed under water and wastewater chloramination conditions, hydrazine formation was below detection when free ammonia was <0.2 mg/L." The SFPUC treatment target for free ammonia is 0.05 mg/L, which is consistently met (quite unusual to reach 0.10 mg/L). Based on the report findings hydrazine does not appear to pose a concern. Commercial labs do not test for hydrazine at such low levels (below 10 ng/L) in drinking water. Therefore, Najm et al. (2006) used a computer model simulation to evaluate impact of major water quality parameters on hydrazine formation. Consistent with the lab results, the model predicted that **at pH < 9.5 and free ammonia less than 0.5 mg/L N hydrazine formation would be of no significant concern in chloraminated water. SFPUC operating targets are well below these levels.**

Idea of prefiltration to remove organic matter before disinfection. The use of prefiltration would allow continued use of chlorine as water disinfectant thus eliminating all the harmful effects of chloramine.

SFPUC continues to apply free chlorine for primary disinfection of pathogenic cysts, bacteria, and viruses. Free chlorine is also used by SFPUC for pipeline disinfection and water tank disinfections after outages or construction. Chloramine is used for residual disinfection in the distribution system.

The Cost and Benefit of NOM Removal. Chemical pretreatment and filtration are already used at two SFPUC treatment plants. This treatment lowers but does not prevent THM or other chlorinated DBP formation during chlorination. **The removal of natural organic matter (NOM) from the Hetch Hetchy water would require chemical pretreatment by adding aluminum or iron coagulant salts and filtration of 300 million gallons of water per day. A facility capable of this type of treatment would probably cost around $500 million** and have estimated operating costs of more than $6.5 million per year, based on recent general cost estimates from AWWA for membrane filtration plants (AWWA, 2005). **There would be significant operational impacts of filtration, including loss of gravity fed system and the need for pumping all water delivered to the Bay Area.**

There is no guarantee that even such costly treatment would allow SFPUC and its retail customers to remain in compliance with DBP regulations with chlorine disinfection in the distribution system. Disinfection by-product (DBP) precursor removal efficiencies are site-specific and vary with different source waters and treatment techniques.

Potential Unintended Consequences of NOM Removal. DBP precursor removal may also carry unintended effects. Because coagulation and filtration remove total organic carbon (TOC) but not bromide, in some waters containing high levels of bromide there may be an increase in the bromide-to-TOC ratio and a shift to more brominated species during chlorination (although this would not be expected in SFPUC waters). Brominated DBPs may be of higher health concern than the chlorinated species within the same class (Bull et al. 2001). More significantly, **addition of salts could increase both aluminum and sulfate content of the water, both of which may cause increased corrosion in soft Hetch Hetchy water.**

Concerns about chloramine generating pinhole leaks in copper pipes

Localized corrosion of copper, or “pitting” corrosion is very complex, and resulting pinhole leaks are still poorly understood and remediation strategies are not completely developed. **Pitting corrosion of copper has not been reported in the literature to date as a chloramine concern. Limited amount of studies attempting to demonstrate pitting corrosion of copper in the lab have been done with free chlorine** and the evidence seems to point out to high levels of aluminum as being necessary to start copper pitting corrosion with free chlorine – this is a very preliminary finding based on a limited number of laboratory tests. The levels of aluminum in SFPUC treated waters are more than 20 times lower than amount used in experiments to simulate pitting copper corrosion. Also, the **presence of disinfectant residual is essential to prevent microbially induced pitting corrosion.**

Federal Regulation for Lead and Copper. Copper in drinking water is regulated by the Lead and Copper Rule (LCR), a Federal and State drinking water standard (Title 22 CCR, Chapter 17.5) that specifies requirements for copper in drinking water systems, measured at customers’ taps. The action level refers to a concentration measured at the tap rather than in municipal water supply system because much of the copper in drinking water is derived from household plumbing. The leaching of copper in the home distribution system is greater if the water is slightly acidic or very soft. **SFPUC lead and copper corrosion control treatment consists of maintaining high water pH throughout the distribution system. This practice is typical for water systems serving low alkalinity high quality water from mountain supplies. SFPUC has monitored for copper numerous times as part of LCR compliance and has always been in compliance with the Action Level for copper, including several samplings after chloramine conversion.**

Uniform Corrosion. Copper corrosion is categorized as either uniform or localized based on visual inspection (Edwards et al., 1994). High uniform corrosion rates are typically associated with waters of low pH and low alkalinity; corrective treatment involves raising pH or increasing bicarbonate. If uniform corrosion rates are excessive, unacceptable levels of copper corrosion by-products may be introduced into drinking waters, which in turn, may lead to consumer complaints of green or blue water caused by copper-containing particles in water. Perforation of the pipe wall and associated failure are rare under uniform corrosion (Edwards et al, 1994).

Types of Non-Uniform Pitting Corrosion. By comparison, localized copper corrosion often appears nearly at random in a distribution system. The problems can be especially evident in new housing developments where some homes may have severe localized corrosion problems whereas others are unaffected, or in corrosion problems that seem isolated to specific floors of tall buildings. Pitting corrosion may be troublesome because of unacceptable metal release or because of the perforation of the pipe wall. Three distinct types of pitting are commonly recognized, encompassing cold, hot, and soft waters (Edwards et al., 1994). Cold water pitting is the most common cause of copper pipe failures. Hot water pitting failures usually take some years to occur, in contrast to cold-water pitting in which failures may occur in just a few months. Soft water pitting was previously thought to be very rare. Waters supporting soft water pitting are cold, of low conductivity, of low alkalinity, and of relatively high pH. Chloride appears to inhibit pitting in practice, whereas sulfate and nitrate appear important. Natural organic matter

(NOM) seems to prevent or in some cases it appears to increase certain copper corrosion within distribution systems. Increased corrosion by-product release and pitting attack may be possible subsequent to NOM removal (Edwards et al., 1994).

Summary of Recent Pitting Copper Corrosion Studies. Chlorine has been observed to both increase and decrease the corrosion of copper. Chlorine residual of 2 mg/L Cl_2 decreased the copper corrosion rate in a water at pH 9.3, leading to the conclusion that a chlorine residual might prevent the unusual "blue water" or soft water pitting problems (Boulay and Edwards, 2001). The presence of organic matter increased copper corrosion by-product release. In another study, a chlorine dose of 0.7 mg/L Cl_2 increased copper by-product release at pH 9.5 but the effects were small. Moreover, chlorine is known to stop other copper corrosion problems in soft waters such as pitting corrosion (Boulay and Edwards, 2001).

Localized corrosion of copper, or "pitting" corrosion, and resulting pinhole leaks are still poorly understood and remediation strategies are not completely developed. To fully understand copper pitting and pinhole leaks, one needs to consider a number of factors, including chemistry of the water, nature of the pitting problem, and detailed analysis of the internal pipe surface (Lytle et al, 2005). Sulfate and chloride were deemed important in the pitting process based on their presence in the corrosion regions (Lytle et al., 2005).

Short-term preliminary experiments on copper pipe corrosion were conducted by Marshall et al (2003) with free chlorine at doses up to 4.8 mg/L Cl_2 (dosed after 22 days of exposure at 6 mg/L Cl_2) and aluminum at 2 mg/L Al. If the aluminum was present, copper corroded as fast at pH 9 as it did at pH 6 without aluminum. The presence of chlorine and aluminum seemed to initiate pitting corrosion of copper. Follow-up experiments by Marshall and Edwards (2005) reproduced for the first time in the lab, according to the authors, pinhole leaks in copper pipes in potable water containing aluminum (2 mg/L Al) and high free chlorine residual (4 mg/L Cl_2). Severe pitting was observed in the presence of free chlorine and aluminum at pH 9.2, whereas no pitting was observed in the absence of aluminum. If chlorine and aluminum were present, the tendency of copper to pit actually became worse at higher pH. The levels of aluminum in SFPUC treated waters are more than 20 times lower than amount used in experiments to simulate pitting copper corrosion.

Microbially Influenced Corrosion. Pitting corrosion of copper pipes in hot and cold water can result from microbial influenced corrosion (MIC) and has been observed world wide (Germany, England, Sweden, Saudi Arabia). High numbers of bacteria were associated with the pits, the presence of bacteria did not always result in pitting and the range of bacterial species was quite variable. A combination of factors appears to contribute to the biocorrosion of copper pipe: soft waters with low pH, high suspended solids and assimilable organic carbon (AOC) content, long-term periods of stagnation of water in the pipe, which produces widely fluctuating oxygen concentrations; low to nonexistent levels of chlorine; maintenance of water temperatures that promote rapid growth and activity of naturally occurring bacteria that form biofilm on the pipe wall (Bremer et al., 2001).

Concerns about chloramine promoting the growth of bacteria in point of use devices in homes

The regrowth of bacteria in customers' plumbing is controlled if there is disinfectant residual (no stagnation and proper maintenance of point of use devices). Based on the review of SFPUC water quality data, **chloramine disinfectant residuals are more stable in SFWS than free chlorine, and chloramine better controls regrowth of coliform and heterotrophic plate count (HPC) bacteria in the distribution system than free chlorine**. The study of *Legionella* occurrence in SFWS conducted by CDC, SFPUC, SF Dept. of Public Health, and California Dept. of Health Services and reported by Flannery et al. (2006) showed that **chloramine virtually eliminated *Legionella* in SFWS.**

Strickhouser et al. (2006) evaluated the regrowth of *Legionella pneumofila* and *Mycobacterium avium* under conditions of increased temperature of 37^{o}C simulating the conditions of the water heaters. The samples were spiked with domestic heater water and outdoor pond water. No regrowth of bacteria was detected for samples with free chlorine above 0.25 mg/L and chloramine above 0.4 mg/L. The regrowth of bacteria occurred in samples without the disinfectant and especially for samples with the high levels of free ammonia (1 mg/L), simulating the conditions of stagnant water with no disinfectant residual.

Given these results, **regrowth of bacteria in well maintained point-of-use devices (POUD) should not be a concern within the SFPUC service area.**

Concerns about chloramine leaching elasticizer from PVC pipes, which may be possible carcinogen

There are no PVC pipes in SFPUC distribution system. The concern may refer to an initial deterioration following chloramine conversion of certain older rubber components of toilet tanks and hot water heaters. These concerns have been known for years and information on how to address this was included in the outreach program.

Concern that chloramine is a weaker disinfectant and that it creates E coli bacteria in the water that haunts the HIV community

SFPUC relies on free chlorine for primary disinfection of pathogenic cysts, bacteria, and viruses at two of its treatment facilities. One SFPUC treatment facility uses a combination of ozone followed by free chlorine for primary disinfection. ***Free chlorine is also used by SFPUC for pipeline disinfection and water tank disinfections after outages or construction.*** *Chloramine is used as a residual disinfectant to maintain disinfection throughout the distribution system.* ***Chloramine is an approved primary and secondary disinfectant by the US EPA (US EPA, 1990). WHO (1996) states that chloramine is useful for maintaining a residual disinfectant in distribution systems.***

Mechanism of Chlorine and Chloramine Disinfection. Rates of microbial inactivation depend upon several factors including: nature of the disinfectant, concentration of the disinfectant, contact time, temperature, type and number of organisms, pH, disinfectant demand (Jacangelo et al., 1987). **It has been suggested that free chlorine and chloramine act by two different mechanisms.** Free chlorine is a very reactive material and rapidly reacts with nucleic acids, most nucleotides, purine and pyrimidine bases, proteins and amino acids. Carbohydrates and lipids are generally unreactive to chlorine. Chloramine reacts rapidly only with the sulfur-containing amino acids, and the heterocyclic aromatic amino acid, tryptophan. Slow reactions of chloramine were observed with nucleic acids, purine and pyrimidine bases and the alpha amino group of amino acids. These slow reactions may become important when the rapidly reacting materials are masked or buried (Jacangelo et al., 1987). **Most studies on the mode of action of free chlorine in bacteria have implicated the disruption of the cell membrane. Chloramine did not severely damage the cell envelope. Chloramine inactivation has been suggested to occur through the blockage or destruction of several enzymes and cofactors. The mode of action of chloramine appears to involve multiple hits by the disinfectant on the bacterial cell and reactions at several sensitive sites** in the bacteria, which precede inactivation (Jacangelo, et al., 1987).

Although chloramine is a weaker oxidant and disinfectant than chlorine, which is actually an advantage in the distribution system because chloramine is not as reactive, lasts and disinfects longer, the disinfection effectiveness of chloramine should not be discounted. Studies have shown that chloramine may match the effectiveness of free chlorine when contact times are more than 45 minutes. Additionally, chloramine has shown superior performance when facing established biofilms. These results have led to the wide use of chloramine as residual disinfectant in distribution systems (AWWA, 2006a).

The "C x t" Concept. **Disinfection of pathogens is achieved by providing specific concentration of the disinfectant in mg/L, C, after contact time in minutes, T (the CT concept).** Promulgation of the Surface Water Treatment Rule (SWTR) in 1989, for the first time in the history of US drinking water treatment required specific CT values to be achieved during treatment of surface waters on a daily basis. The SWTR's main target organisms were viruses and *Giardia lamblia* (McGuire, 2006). Additionally, SWTR mandates maintaining disinfectant residual in the distribution system. **Given longer detention times in the distribution system, high pH necessary for corrosion control that reduces the disinfecting power of chlorine but does not impact chloramine, and the fact that chloramine residuals in the SFPUC distribution system are higher than equivalent residuals of free chlorine (chloramine is longer-lasting and reacts at a lower rate), residual disinfection with chloramine in the distribution system is superior to free chlorine.**

Synergistic Effects of Multiple Disinfectants and the Future Trends in Drinking Water Disinfection. This above analysis does not take into account potential synergistic or cumulative effect of applying two different disinfectants sequentially (free chlorine for primary disinfection followed by chloramine for secondary disinfection). **Studies have shown that chlorination followed by chloramination is more effective for disinfection of the protozoan *Cryptosporidium parvum* oocysts than chlorine alone** (West et al., 1998). **The future of**

drinking water disinfection will rely on multiple disinfectants applied in sequence (Trussell, 2006).

Results of SFPUC System Monitoring. SFPUC monitors its distribution system for coliform bacteria as mandated by the Total Coliform Rule (TCR). Additionally, although not required, SFPUC monitors its distribution system for heterotrophic plate count (HPC) bacteria using the sensitive R2A method. **Chloramination has both improved TCR compliance and lowered the levels of HPC bacteria in the distribution system by at least a factor of 10, as compared with free chlorine.** This is likely due to higher and longer-lasting disinfectant residuals provided by chloramine. **Similarly, chloramination has virtually eliminated the presence of *Legionella* species in San Francisco in hot water heaters** (Flannery et al., 2006). *Legionella* bacteria were found to be much more resistant to chlorine than E. coli and other coliforms that have been used as indicator organisms to monitor potable water quality (Kim et al., 2002). *Legionella* bacteria have been known to cause pneumonic legionellosis and severe influenza-like illness. It has been reported that hospitals supplied with drinking water containing free chlorine were more likely to have a reported outbreak of Legionnaires' disease than those that used water containing chloramine (Kim et al., 2002).

Immuno-compromised individuals may or may not consider boiling drinking water regardless of the disinfectant applied, depending on recommendations from their physician. It is technologically impossible to provide sterile drinking water by any utility.

Concern about the use of chloramine as an unproven disinfectant. Concerns about chloramine safety and putting customers first

History of Chlorine and Chloramine Disinfection. **Both chlorine and chloramine have been used for disinfection for about the same length of time. The first regular use of chlorination in the United States was in 1908 (AWWA, 1998).** It is interesting to note that it took a court dispute and a legal deadline to clear away the objections and to apply chlorine (McGuire, 2006). By 1917, free chlorine disinfection was adopted in hundreds of US water utilities, but it caused taste and odor problems. Chlorine readily combines with phenol to produce a wide variety of chlorophenols that at low concentrations impart a strong and obnoxious medicinal odor to water. In addition, chlorine itself has a significant, penetrating, and disagreeable odor (McGuire, 2006).

In 1917 in Ottawa, Ont., a combination of ammonia and chlorine was implemented to solve taste and odor problems related to free chlorine (McGuire, 2006). Chloramine has been used for disinfection in the United States since that time (US EPA, 1999; Kirmeyer et al, 2004)). Chloramination enjoyed its greatest popularity between 1929 and 1939. In 1938, based upon replies to a questionnaire from 2,541 water suppliers in 36 states, 407 utilities reported using ammonia with chlorine. **Denver, CO, has used chloramination process continuously since 1917** (McGuire, 2006).

The Metropolitan Water District of Southern California (MWDSC) implemented the use of chloramination in 1941 when Colorado River water was first delivered to Southern California.

Chloramine disinfection was used so that a sufficient residual could be carried to the furthest reaches of the MWDSC distribution system (McGuire, 2006).

Many utilities in California serving population of over 15 million have been using chloramine for over 20 years. Chloramine is used world wide in North America, Australia, in Europe in the United Kingdom and Finland.

Current SFPUC Regulatory Compliance for Disinfection and the Future of Drinking Water Disinfection. Water provided by SFPUC meets all drinking water regulations. Pathogens are controlled by watershed protection, primary disinfection with chlorine or ozone plus chlorine (at one plant), distribution system disinfection with chloramine, cross-connection control, and other water quality maintenance practices.

Water utilities do not conduct basic research. Decisions are based on US EPA and California DHS approved technologies and cost considerations. **Chloramine has performed very well in the SFPUC distribution system significantly reducing the formation of regulated disinfection by-products and allowing SFPUC to meet current and future US EPA regulations. At the same time, chloramine has improved control of biofilm in SFPUC distribution system lowering the incidence of coliform positive samples, reducing heterotrophic plate count (HPC) bacteria by an order of magnitude, and virtually eliminating *Legionella* from the hot water heaters in large buildings.**

SFPUC continues to evaluate disinfection processes; e.g., the use of UV light disinfection to augment chlorination for Hetch Hetchy source water to meet future drinking water regulations. Protozoan pathogens, e.g., *Cryptosporidium parvum*, have been found in the last 10 years to be resistant to chlorine disinfection but very sensitive to ultraviolet (UV) light. As a result, **chlorine's dominance for disinfection will be changing and the water industry has entered a new age – one in which UV light will play an increasingly important role in disinfection and in which combinations of disinfectants are often required to provide a strong defense against a variety of target organisms** (Trussell, 2006). **SFPUC has implemented a combination of disinfectants, chlorine followed by chloramine, to better disinfect the water.** In the future, other disinfectants, e.g. UV light, may be added to continually improve the disinfection process, meet future regulations and better serve SFPUC customers.

References for Section E:

Amato R.L., 2005. Water Treatment for Hemodialysis - Updated to Include the Latest AAMI Standards for Dialysate (RD52: 2004). Nephrology Nursing Journal, 32(2):151-170.

American Academy of Dermatology website, accessed September 20, 2006:
Pruritis: http://www.aad.org/public/Publications/pamphlets/Pruritus.htm
Dry Skin and Keratosis Pilaris:
http://www.aad.org/public/Publications/pamphlets/Dry+SKin+and+Keratosis+Pilaris.htm

Aschengrau A, Zierler S, Cohen A. Quality of community drinking water and the occurrence of late adverse pregnancy outcomes. Arch Environ Health 1993;48:105-13.

AWWA (1998), Water Treatment Plant Design, Third Edition, McGraw-Hill

AWWA (2005), Microfiltration and Ultrafiltration Membranes for Drinking Water, Manual of Water Supply Practices – M53, First Edition, Denver, CO.

AWWA (2006), Webcast "Changing Disinfectants: The Impacts on Distribution System Water Quality", August 24, 2006.

AWWA (2006a), Water Chlorination/Chloramination Practices and Principles, Manual of Water Supply Practices – M20, Second Edition, Denver, CO.

AWWA Research Foundation (2000). Emerging Chemicals Issue Group meeting, July 11-13, 2000.

Baribeau H. et al (2006), Formation and Decay of Disinfection By-Products in the Distribution System, AWWA Research Foundation, Denver, CO.

Bircher AJ: Water-induced itching. Dermatologica 1990;181:83-87.

Boulay N., Edwards M. (2001), Role of Temperature, Chlorine, and Organic Matter in Copper Corrosion By-Product Release in Soft Water, Water Research, vol. 35, 3, 683-690.

Bove FJ et al. Public drinking water contamination and birth outcomes. Am J Epidemiol 1995;141:850-62.

Bremer P.J., Webster B.J., Wells D.B. (2001), Biocorrosion of Copper in Potable Water, Journal AWWA, vol. 93, 8, 82.

Bruchet, A.; N'Guyen,K.;Mallevialle, J.; & Anselme, C. (1989). Identification and Behavior of Iodinated Haloform Medicinal Odor. Proceedings, AWWA Seminar on Identification and Treatment of Taste and Odor Compounds, Los Angeles, CA., pp.125-141.

Bull R.J., Krasner S.W., Daniel P.A., Bull R.D. (2001), Health Effects and Occurrence of Disinfection By-Products, AWWA Research Foundation, Denver, CO.

Bull RJ et al. Water chlorination: essential process or cancer hazard? Fundam Appl Toxicol 1995;28:155-66.

Centers for Disease Control and Prevention (CDC). National Center for Health Statistics (NCHS). National Health and Nutrition Examination Survey Data. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2003-2004, http://www.cdc.gov/nchs/about/major/nhanes/nhanes2003-2004/nhanes03_04.htm

Connell G.F. (1997), The Chlorination/Chloramination Handbook, AWWA, Denver, CO.

Doyle TJ et al. The association of drinking water source and chlorination by-products with cancer incidence among postmenopausal women in Iowa: a prospective cohort study. Am J Public Health 1997;87:1168-76.

du Peloux Menage H, Greaves MW: Aquagenic pruritus. Semin Dermatol 1995;14:313-316.

Edwards M., Ferguson J.F., Reiber S.H. (1994), The Pitting Corrosion of Copper, Journal AWWA, vol. 86, 7, 74.

Environmental Protection Agency. 1992. Integrated Risk Information System: Monochloramine (CASRN 10599-90-3). http://www.epa.gov/iriswebp/iris/subst/0644.htm

Environmental Protection Agency. 1994. Drinking Water Criteria Document for Chloramines Final Draft ECAO-CIN-D002. March, 1994.
http://www.epa.gov/ncea/pdfs/water/chloramine/dwchloramine.pdf

Fenster L et al. Tap or bottled water consumption and spontaneous abortion in a case- control study of reporting consistency. Epidemiology 1992;3:120-4.

Flannery B., Gelling L.B., Vugia D.J., Weintraub J.M., Salerno J.J., Conroy M.J., Stevens V.A., Rose C.E., Moore M.R., Fields B.S., Besser R.E. (2006), Reducing Legionella Colonization in Water Systems with Monochloramine, Emerg Infect Dis., vol. 12, 4, 588-596.

Gallagher MD et al. Exposure to trihalomethanes and adverse pregnancy outcomes. Epidemiology 1998;9:484-9.

Hansson, R.C.; Henderson, M.J.; Jack, P.; & Taylor R.D. (1987). Iodoform Taste Complaints in Chloramination. Water Res., 21:10:1265-1271.

Heffelfinger JD, Kool JL, Fridkin S, Fraser VJ, Hageman J, Carpenter J, Whitney CG; Society for Healthcare Epidemiology of America. Risk of hospital-acquired legionnaires' disease in cities using monochloramine versus other water disinfectants. Infect Control Hosp Epidemiol. 2003 Aug;24(8):569-74

Jacangelo J.G., Olivieri V.P., Kawata K. (1987), Mechanism of Inactivation of Microorganisms by Combined Chlorine, AWWA Research Foundation, Denver, CO.

Kim B.R., Anderson J.E.,, Mueller S.A., Gaines W.A., Kendall A.M. (2002), Literature Review – Efficacy of Various Disinfectants Against Legionella in Water Systems, Water Research, vol. 36, 4433-4444.

King WD, Dodds L, Allen AC. Relation between stillbirth and specific chlorination by-products in public water supplies. Environ Health Perspect 2000;108:883-6.

Kirmeyer et al. (2004), Optimizing Chloramine Treatment, Second Edition, AWWA Research Foundation, Denver, CO.

Kool JL, Carpenter JC, Fields BS. Effect of monochloramine disinfection of municipal drinking water on risk of nosocomial Legionnaires' disease. Lancet. 1999 Jan 23;353(9149):272-7.

Kramer MD et al. The association of waterborne chloroform with intrauterine growth retardation. Epidemiology 1992;3:407-13.

Krasner S.W. McGuire M.J., Jacangelo J.G., Patania N.L., Reagan K.M., Aieta E.M. (1989), The Occurrence of Disinfection By-Products in US Drinking Water, Journal AWWA, vol. 81, 8, 41.

Lubbers JR, Chaudan S, and Bianchine JR. 1981. Controlled clinical evaluations of chlorine dioxide, chlorite and chlorate in man. Fundam. Appl Toxicol 1:334. (As described in Guidelines for Canadian Drinking Water Quality Supporting Document: http://www.hc-sc.gc.ca/ewh-semt/pubs/water-eau/doc_sup-appui/chloramines/index_e.html)

Lytle D.A., Payne J.M., Feldhaus J. (2005), Copper Pitting Corrosion in a Drinking Water Distribution System, AWWA Annual Conference Proceedings.

Marshall B., Rushing J., Edwards M. (2003), Confirming the Role of Aluminum Solids and Chlorine in Copper Pitting Corrosion, AWWA Annual Conference Proceedings.

Marshall B., Edwards M. (2005), Copper Pinhole Leak Development in the Presence of Al(OH)3 and Chlorine, AWWA Annual Conference Proceedings.

McGuire M. J. (2006), Eight Revolutions in the History of US Drinking Water Disinfection, Journal AWWA, vol. 98, 3, 123.

Moore GS, Calabrese EJ, & McGee M. 1980. Health effects of monochloramine in drinking water. J Environ Sci Health, A15: 239-258.

Morris RD et al. Chlorination, chlorination by-products, and cancer: a meta-analysis. Am J Public Health 1992;82:955-63.

Najm I. et al. (2006), Formation of Hydrazine as a Chloramine By-Product, AWWA Research Foundation, Denver, CO.

Nieuwenhuijsen MJ et al. Chlorination disinfection byproducts in water and their association with adverse reproductive outcomes: a review. Occup Environ Med 2000;57:73-85.

Plewa, M.J., Wagner, E.D., Richardson S.D., Thurston A.D., Jr., Woo Y.T., McKague A.B. (2004) "Chemical and Biological Characterization of Newly Discovered Iodoacid Drinking Water Disinfection Byproducts", Environmental Science & Technology, 38, 18, 4713-4722.

Reif JS et al. Reproductive and developmental effects of disinfection by-products in drinking water. Environ Health Perspect 1996;104:1056-61.

Richardson, S.D. (2004), Personal communication. research Chemist, National Exposure Research Laboratory, U.S. Environmental Protection Agency, Athens, GA.

Savitz D.A., Singer P.C. et al. (2005), Drinking Water Disinfection By-Products and Pregnancy Outcome, AWWA Research Foundation, Denver, CO.

Savitz DA, Andrews KW, Pastore LM. Drinking water and pregnancy outcome in central North Carolina: source, amount, and trihalomethane levels. Environ Health Perspect 1995;103:592-6.

Singer P.C. (1999), Formation and Control of Disinfection By-Products in Drinking Water, AWWA, Denver, CO.

Strickhouser A., Falkinham J., Edwards M. (2006), The Effect of Nutrients and Disinfection on Microbial Regrowth During Storage in Domestic Water Heaters, AWWA Annual Conference Proceedings.

Swan SH, Waller K, Hopkins B, Windham G, Fenster L, Schaefer C, Neutra RR. A prospective study of spontaneous abortion: relation to amount and source of drinking water consumed in early pregnancy. Epidemiology. 1998 Mar;9(2):126-33.

Trussell R.R. (2006), Water Treatment: The Past 30 Years, Journal AWWA, vol. 98, 3, 100.

United Nations Environment Programme, International Labour Organisation, World Health Organization, International Programme On Chemical Safety. Environmental Health Criteria 216. Disinfectants And Disinfectant By-Products. 2000.
http://www.inchem.org/documents/ehc/ehc/ehc216.htm

U.S. Department of Health and Human Services. NTP TR 392 Toxicology and Carcinogenesis Studies of Chlorinated Water (CAS Nos. 7782-50-5 and 7681-52-9) and Chloraminated Water (CAS No. 10599-90-3) (Deionized and Charcoal-Filtered) in F344/N Rats and B6C3F1 Mice (Drinking Water Studies) March 1992.

US EPA (1990), Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources, published by AWWA.

US EPA (1999), Alternative Disinfectants and Oxidants Guidance Manual, EPA 815-R-99-014.

Valentine R.L. et al. (2005), Factors Affecting the Formation of NDMA in Water and Occurrence, AWWA Research Foundation, Denver, CO.

Von Gunten, U. (2003) "Ozonation of Drinking Water: Part II. Disinfection and Byproduct Formation in Presence of Bromide, Iodine or Chlorine." Water res. Apr; 37(7): 1469-87

Waller K., Swan S.H., DeLorenze G., Hopkins B. (1998), Trihalomethanes in Drinking Water and Spontaneous Abortion, Epidemiology, vol. 9, 2, 134-140.

Weinberg, H.S., Krasner S.W., Richardson S.D., Thruston A.D., Jr. (2002) " The Occurrence of Disinfection Byproducts (DBPs) of Health Concern in Drinking Water: results of a Nationwide DBP Occurrence Study. http://www.epa.gov/athens/publications/DBP.html

Weintraub, J.M., Berger, M., & Bhatia, R, 2006. Heterogeneous dermatitis complaints after change in drinking water treatment: a case report. Environ Health, 9:5:18

West T., Daniel P., Boozarpour M. DeGraca A., Labonte J., Clancy J. (1998), Inactivation of Cryptosporidium through Chlorine-Chloramine Disinfection, Proceedings of AWWA Annual Conference, Dallas, TX.

White G.C. (1999), Handbook of Chlorination and Alternative Disinfectants, Fourth Edition, John Wiley Interscience, New York.

WHO (1996), Guideline for Drinking Water Quality, Vol 2, Chap 16 Disinfectants and Disinfection By-Products.

Wones RG, Deck CC, Stadler B, Roark S, Hogg E, Frohman LA. Effects of drinking water monochloramine on lipid and thyroid metabolism in healthy men. Environ Health Perspect. 1993 Mar;99:369-74.

Zierler S, Danley RA, Feingold L. Type of disinfectant in drinking water and patterns of mortality in Massachusetts. Environ Health Perspect. 1986 Nov;69:275-9.

Zierler S, Feingold L, Danley RA, Craun G. Bladder cancer in Massachusetts related to chlorinated and chloraminated drinking water: a case-control study. Arch Environ Health. 1988 Mar-Apr;43(2):195-200.

Zierler S. Drinking water and reproductive health. Epidemiology 1992;3:77-8.

REFERENCES

Boyette, M.D., D.F. Ritchie, S.J. Carballo, S.M. Blankenship, and D.C. Sanders. 1993. Chlorination and Post-Harvest Disease Control. North Carolina Cooperative Extension Service, Raleigh, NC. http://www.bae.ncsu.edu/programs/extension/publicat/postharv/ag-414-6/index.html.

Davis, M.L. and D.A. Cornwell. 1998. Introduction to Environmental Engineering. McGraw-Hill (Boston, MA).

Driscoll, Charles T., Raymond D. Letterman, and David E. Fitch. 1987. Residual Aluminum in Filtered Water. AWWA Research Foundation, Denver, CO. 71 pp.

Gabelich, Christopher J., Kenneth P. Ishida, Fredrick W. Gerringer, Ray Evangelista, Minhaal Kalyan, and I.H. Suffet. 2004. Control of Residual Aluminum from Conventional Treatment to Improve Reverse Osmosis Performance. University of Calfornia *Postprints*, Paper 1328. http://repositories.cdlib.org/postprints/1328.

Hundt, Thomas R. and Charles R. O'Melia. 1988. Aluminum-Fulvic Acid Interactions: Mechanisms and Applications. *Journal AWWA*, 80(4): 176-186.

Letterman, Raymond D. and Charles T. Driscoll. 1988. Survey of Residual Aluminum in Filtered Water. *Journal AWWA*, 80(4): 154-158.

Letterman, Raymond D. and Charles T. Driscoll. 1994. Control of Residual Aluminum in Filtered Water. AWWA Research Foundation, Denver, CO. 93 pp.

Letterman, Raymond D., Appiah Amirtharajah, and Charles R. O'Melia. 1999. Coagulation and Flocculation. In *Water Quality and Treatment*. Edited by Raymond D. Letterman. New York: McGraw-Hill.

Loganathan, G.V. and Juneseok Lee. 2005. Decision Tool for Optimal Replacement of Plumbing Systems. Civil Engineering and Environmental Systems, 22(4):189-204.

Marshall, Becki. 2004. Initiation, Propagation and Mitigation of Aluminum and Chlorine Induced Pitting Corrosion. Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Maryland Department of Housing and Community Development (2004). Pinhole Leaks in Copper Plumbing (Task Force Study – Final Report). http://www.dhcd.state.md.us/Website/document/Pinhole_Leaks_in_Copper_Plumbing.pdf

Miller, R.G., et al. 1984. The Occurrence of Aluminum in Drinking Water. *Journal AWWA*, 76(1): 84.

O'Melia, Charles R., Kimberley A. Gray and Chonghua Yao. 1989. Polymeric Inorganic Coagulants. AWWA Research Foundation, Denver, CO. 91 pp.

PADEP (Pennsylvania Department of Environmental Protection). Not dated (n.d.). Coagulation Job Aid – Part 2. www.earthwise.dep.state.pa.us/content/knowledge docs/pdf/coagjobaidpart2.pdf

Pernitsky, David J. and James K. Edzwald. 2006. Selection of Alum and Polyaluminum Coagulants: Principles and Applications. *AQUA – Journal of Water Supply: Research and Technology*, 55(2): 121-141. http://www.awwoa.ab.ca/pdfs/Polyaluminum%20 coagulants.pdf.

Pernitsky, David J. 2004. Coagulation 101. Alberta Water and Wastewater Operator Association. Available at http://www.awwoa.ab.ca/pdfs/Coagulation%20101.pdf.

Pernitsky, David J. 2001. Drinking Water Coagulation with Polyaluminum Coagulants: Mechanisms and Selection Guidelines. Doctoral Dissertation, the University of Massachusetts (Amherst, MA). 329 pp. http://scholarworks.umass.edu/dissertations/ AAI3027241.

Phuu, Huyonh. 2006. Study on Manufacture of Inorganic Coagulants (Polypolyaluminum Chloride) for the Treatment of Surface Water & Applied to Safe Water Supplies & Environmental Sanitary on the Delta Mekong. 7pp. http://stn.nsc.gov.tw/en/_view detail.asp?doc_uid=0950518001

Reiber, Steve. 2003. HDR Technical Memorandum from Steve Reiber to Andy Kireta, Copper Development Association Inc. – Electrochemical Study of Copper Pitting, October 8, 2003.

Rushing, Jason Clark. 2002. Advancing the Understanding of Water Distribution System Corrosion: Effects of Chlorine and Aluminum on Copper Pitting, Temperature Gradients on Copper Corrosion, and Silica on Iron Release. Master's Thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA (July 24, 2002). http://scholar.lib.vt.edu/theses/available/etd-07292002 124850/unrestricted/Rushing ETD.pdf

Rushing, J.C. and M. Edwards. 2004. Effect of Aluminum Solids and Free Cl_2 on Copper Pitting. *Corrosion Science*, 46(12): 3069-3088.

Srinivasan, PT, T. Viraraghavan, and K.S. Subramanian. 1999. Aluminum in Drinking Water: An Overview. *Water SA*, 15(1) 47-56. http://www.wrc.org.za/ archives/watersa%20archive/1999/January/jan99_p47.pdf

USACE (US Army Corps of Engineers). 2001. Engineering and Design: Precipitation/ Coagulation/Flocculation (Manual No. 1110-1-4012). Washington, D.C. Nov. 15, 2001. http://www.usace.army.mil/publications/eng-manuals/em1110-1-4012/entire. pdf.

INTERVIEW 1

Subject: ***Washington Suburban Sanitary Commission Interview***

On October 23, 2006, EE&T conducted a phone interview with Plato Chen, a Senior Scientist at the Washington Suburban Sanitary Commission (WSSC), as directed under Task 4 of the Modification to Scope of Services for the Sodium Hypochlorite and Caustic Soda Facilities Project for the Washington Aqueduct (WA) Division. The interview primarily dealt with operations at the WSSC's Potomac River plant. This memo summarizes the pertinent information discussed during the interview.

Sodium Hypochlorite vs. Chlorine Gas

The WSSC does not use sodium hypochlorite at either of their plants. They have not even considered switching to hypochlorite, primarily because limited available space at the Potomac plant prevents the installation of adequate hypochlorite storage volume, and the cost of feeding hypochlorite is significantly higher. They also believe the chlorine demand at their plants it too great to be met by on-site hypochlorite generation. They also do not have any problems using chlorine gas, and it is significantly cheaper than sodium hypochlorite.

PACl

The WSSC began using PACl at the Potomac River plant in the mid-90's. Prior to the switch, the plant was using ferric chloride for coagulation. The WSSC switched to PACl due to high variability of their source water supply. Unlike the Washington Aqueduct's plants, the WSSC's Potomac River plant draws directly from the Potomac River. Approximately one-quarter of a mile above the plant's intake, a tributary that drains a highly urbanized area converges with the Potomac. This results in highly variable turbidities and alkalinities during storm events. Mr. Chen characterized the source water quality as "flashy", as influent turbidity can quickly go from 5 ntu to over 1000 ntu, with a concurrent decrease in alkalinity (from ~120 mg/L to ~30 mg/L). While they were still using ferric coagulant, it was necessary to add lime pre-coagulation during these low alkalinity events. The WSSC has found that PACl is less dependent on pH and alkalinity than ferric coagulant, and also gives them better filter performance (lower turbidity and longer filter runs). For these reasons, switching to PACl has enabled the WSSC to more consistently meet the turbidity goals it has committed to as part of the Partnership for Safe Water.

The WSSC's Patuxent River plant doesn't face the same problems with influent water quality variability because they draw from a reservoir. However, Mr. Chen also indicated that they switched to PACl at the Patuxent River plant due to economic reasons (a relatively low cost for PACl through their contract with Fairfax County and lower residuals production).

Coagulation pH

Raw water pH at the Potomac River plant can range from 7.5 to as high as 9.5. Significant diurnal variations in pH occur during the summer due to algal growth in the river. At high pH levels, significant residual aluminum was observed in the filtered water. The pH drop associated with chlorine addition in the clear wells caused the aluminum to precipitate out before leaving the plant, and this resulted in aluminum precipitates in the distribution system, which is suspected to contribute to the problem of copper pinhole leaks. To prevent this from occurring, operations began dosing sulfuric acid keep the raw water pH less than 7.5 prior to coagulation. After this operational adjustment, residual aluminum levels leaving the plant have been acceptable.

The WSSC is also investigating depressing the coagulation pH even lower in order to enhance DBP precursor removal. This is an important issue to the WSSC because they do not chloraminate; instead they rely on free chlorine for secondary disinfection. They found that lowering the coagulation pH to around 6.3 to 6.5 improved removal of DBP precursors by 20 to 30 percent (as measured by SDS tests). However, lowering the pH this far requires a significant amount of acid, as well as a significant amount of lime to raise the pH prior to distribution. The WSSC's target for corrosion control is a finished water pH between 7.5 and 7.8. The WSSC is investigating using caustic soda to trim the pH, but intends to keep using lime for coarse pH adjustment.

During the interview, Mr. Chen mentioned that the current acid delivery system was only recently constructed; they had been operating with a temporary system for a number of years. He thought that the temporary system used plastic tanks and chemical metering pumps, and that the permanent system utilized lined mild steel tanks. He said that he would provide more detailed information regarding the chemical storage after checking the design reports, which will be included in the final report.

Pinhole Leaks

After investigation into numerous complaints of pinhole leaks reported by residents, the WSSC has begun feeding orthophosphate for corrosion control. It is difficult to evaluate the extent of pinhole leaks because it is a self-reported problem, but surveys of area plumbers have indicated that the number of pinhole leaks has decreased since the WSSC began adding orthophosphate. Mr. Chen also mentioned residual aluminum reaching the distribution system has been minimal since the implementation of acid addition to maintain coagulation pH below 7.5.

INTERVIEW 2

Subject: ***Fairfax Water Authority Interview***

During October and November of 2006, EE&T conducted phone interviews with various Fairfax Water Authority personnel, including Melissa Billman, Laboratory Director, Tom Bonaquisti, Director of Water Quality (since retired), Doug Grimes, Corballis Plant Manager and Dale Kovacs with Engineering as directed under Task 4 of the Modification to Scope of Services for the Sodium Hypochlorite and Caustic Soda Facilities Project for the Washington Aqueduct (WA) Division. The interviews dealt with operations at the two Fairfax Water Authority's Plants – Corballis and Griffith. This memo summarizes the pertinent information discussed during the interview.

Fairfax Water Authority (FWA) produces drinking water at two locations. The Corballis plant treats water from the Potomac River and the new Griffith Plant treats water from the Occoquan Reservoir.

The Corballis Plant has a rated capacity of 225 mgd. Treatment there includes addition of potassium permanganate for manganese control, in line static mixers with addition of coagulant and caustic, sedimentation, ozonation, multi media filters and chloramination. The finished water is treated with fluoride, caustic and zinc orthophosphate.

Sodium Hypochlorite vs. Chlorine Gas

The Corballis plant currently uses chlorine gas, but there are plans to convert to HOCL by the middle of 2008. The new Griffith Plant (on line 4 to 5 months ago) was designed with sodium hypochlorite. The Griffith Plant feeds HOCl undiluted. The plant has about 20 days of storage, and degradation of the product has not been a problem. The only problems cited by FWA personnel was that the vents on the tanks were sized too small, so had to be replaced, and the sight tubes leaked and also had to be replaced. The gaskets for these tubes also had to be replaced. The tanks are made of fiberglass; they are located inside of a building.

At Corballis, the plan is to convert to sodium hypochlorite during the Phase 3 upgrades. The intent is to dilute the product to 6 percent. The decision to use diluted product was made based on a recommendation by the design engineer, CDM, with concurrence from FWA. Although no problems had been noted at Griffith Plant with the undiluted product, it was felt that the HOCl could degrade and create off-gas.

A dedicated, heated building will be constructed for the 12 tanks needed to store HOCl on site. The fiberglass tanks will be 12-ft diameter, 26 ft tall and each will hold 20,000 gallons. This will result in a storage capacity of 200,000 gallons of 6 percent HOCl. Two additional tanks will be built for receiving and dilution. The tanks will be trucked to the site in sections. No mixers will be in the tanks. There will also be a water softening system.

The State Health Department requires 30 day storage on site, but FWA requested a permit to only store 15 days.

PACl

Corballis switched to PACl in the mid 1990s and the Griffith Plant was designed to feed it. The transition at Corballis was smooth - the same tanks and feeders were used. The only issue Mr. Bonaquisiti had with PACl is that it sometimes "craps out" in the tanks - meaning a precipitate is formed. The manufacturer apparently cannot explain what causes this, but they were on site the day we spoke with Mr. Bonaquisti cleaning one of the tanks out for the Authority. They use the same product as WSSC -Delta chemical high strength 70 percent baseisity. FWA indicated that a typical dose was 20 mg/L "neat". Because they use the same chemical as WSSC, they get a good price from the supplier.

FWA personnel indicated that the benefit of PACl is much lower solids production and better performance, especially in high turbidity, low alkalinity and low pH water

The Corballis Plant draws directly from the Potomac River. This results in highly variable turbidities and alkalinities during storm events. The source water quality could be characterized as “flashy”, as influent turbidity can quickly go from 5 ntu to over 1000 ntu, with a concurrent decrease in alkalinity (from ~120 mg/L to ~30 mg/L. The water’s pH can also change quickly, and sometimes it is difficult to balance the coagulant feed with the pH and the alkalinity.FWA has found that PACl is less dependent on pH and alkalinity than other coagulants, and also gives them better filter performance (lower turbidity and longer filter runs). For these reasons, FWA personnel are quite happy with the performance of PACl.

The Griffith Plant doesn’t face the same problems with influent water quality variability because they draw from at the Occaquan Reservoir. However, ultimately Griffith and Corballis both experience the same range of influent water quality because they both ultimately draw from the same source; Griffith just doesn’t experience the rapid changes in influent water quality because these changes are attenuated in the reservoir before reaching the plant.

Coagulation pH

Mr. Bonaquisti indicated that the pH of the raw water at Corballis can vary from 6.5 to as high as 9, and the Corballis plant has an operational goal of 7.8 to 8.0. They can feed sodium hydroxide both pre and post for pH adjustment, but they rarely have to do any adjustment pre coagulation. He couldn't remember the last time they had to feed sodium hydroxide to adjust pre pH. In the summer the high pH is caused by algae in the raw water, and they could feed quite a bit of acid at that time. However, Mr. Grimes indicated that the plant does not experience diurnal algae induced fluctuations. He indicated that high pH in the raw water can occur during drought periods, leading to the primary flow being ground water through limestone formations.

Acid, (93 percent sulfuric acid) when needed, is fed in the raw water before the mixer, prior to PACl addition. Acid feed is controlled by a PID (feed back loop) but the pump is adjusted manually, since the alkalinity also needs to be monitored, as well as the pH. It is critical to treatment to balance the pH and the alkalinity.

The target pH for coagulation when acid is used is 7.3 to 7.5, and the finished goal is 7.6 to 7.7. They feed orthophosphate for corrosion control.

At Griffith, they mostly have low pH raw water, so they adjust with sodium hydroxide. They do not have sulfuric acid feed capability at that plant.

Aluminum residual

The Authority routinely monitors for aluminum, but have not seen it at levels of concern. They have had complaints of pitting (a couple) but have investigated and determined that the copper used was thin walled pipe, not manufactured to U.S. specifications, and so it was a materials problem. Marc Edwards from Virginia Tech was consulted on this problem, and he apparently concurred with the authority's assessment.

Disinfection

They use chloramines nine months of the year, and then feed free chlorine in April, May and June to flush out the system.

INTERVIEW 3

Subject: ***Newport News Waterworks Interview***

On December 1, 2006, EE&T conducted an interview with Mike Hotaling, Facilities Manager for the Newport News Waterworks (NNW), as directed under Task 4 of the Modification to Scope of Services for the Sodium Hypochlorite and Caustic Soda Facilities Project for the Washington Aqueduct (WA) Division. This memo summarizes the pertinent information discussed during the interview.

Sodium Hypochlorite vs. Chlorine Gas

NNW currently operates two surface water plants: Hardwoods Mill, which is the system's original water treatment plant, and Lee Hall, the construction of which was completed last year. Both plants utilize ozone as the primary disinfectant and chloramines to maintain the disinfectant residual. Hardwoods Mill also adds free chlorine prior to the filter as needed for manganese control. Hardwoods Mill may discontinue pre-filter chlorine in the future if a new spent-filter backwash (SFBW) treatment system for manganese removal reduces the manganese in the SFBW that is currently discharged back into the reservoir. Pre-filter chlorination is not utilized at Lee Hall both because manganese is not as big a problem at that plant and because the plant uses biofiltration. Hardwoods Mill uses chlorine gas for disinfection, while Lee Hall uses sodium hypochlorite. NNW is planning to switch to sodium hypochlorite at Hardwoods Mill as well, and is currently just waiting for room in the capital improvement program budget.

Sodium hypochlorite is delivered and stored at 12.5 percent at Lee Hall. Originally, the system was designed with four storage tanks sized to provide 30 days storage at average flow, average dose. However, following problems with the HVAC system last summer significant degradation issues were experienced. To reduce degradation NNW reduced the storage volume to only two tanks, providing approximately 15 days storage and, consequently, requiring more frequent deliveries.

Operationally there have been no problems with the hypochlorite. Mike suggests sampling each truck until you have confidence in your supplier to ensure you are getting what is specified. He also suggests specifying in the supply contract that the hypochlorite is to be delivered at ambient temperature. They do not currently have this language in their supply contract, and as a result sometimes receive freshly-made hypochlorite that can be quite hot. This can significantly raise the temperature in the storage tank for several days and, consequently, accelerate degradation of the stored chemical.

Coagulation pH/Caustic Soda

NNW currently uses alum at both treatment plants. Typical alum doses range from 50 to 100 mg/L as dry alum, while raw water alkalinity ranges from 30 to 100 mg/L as $CaCO_3$. As a result of the occasionally low raw water alkalinity it is necessary, at times, to add base during coagulation. Hardwoods Mill uses pebble lime for this purpose, while Lee Hall uses caustic soda. Also, because the Lee Hall plant occasionally receives inflow from an aquifer in contact with limestone, it is occasionally necessary to use sulfuric acid to lower the coagulation pH to the target range (Hardwoods Mill also has acid feed capability but has, thus far, never had to use it.) NNW has found that a target pH range of 6.2 to 6.4 is optimum for coagulation at their plants.

Lee Hall receives and stores caustic soda and sulfuric acid at 25 percent and 93 percent, respectively. The caustic soda is stored indoors, and dose controlled using an automatic pH loop. They have experienced some caustic soda leak issues at the feed pumps due to the Viton seals. NNW will be replacing all Viton seals with EPDM in the future to reduce these leaks.

Caustic soda is only used for coagulation pH control at Lee Hall. NNW has found that, due to the amount of chemical required to raise the pH from the 6.2 to 6.4 range during coagulation to the finished water pH target of around 7.5, it is more economical to use hydrated lime at both plants for final pH control.

Pinhole Leaks

The NNW distribution division did not report any pinhole leaks. NNW regularly monitors for residual aluminum levels, and has found that they are normally below the detection limit.

INTERVIEW 4

Subject:* *Erie County Water Authority Interview

Erie County Water Authority (ECWA) operates two plants – the Sturgeon Point Plant and the Van de Water Plant. Both currently use PACl for coagulation.

The Sturgeon Point Plant uses Lake Erie as a source. It is a conventional facility with a design capacity of 90 MGD. Typically, it operates at 45-70 MGD. The plant processes include potassium permanganate for zebra mussel control, mechanical rapid mixing, for coagulant addition, and then coagulant aid polymers after the initial mixing zone; parallel flocculation split between four-stage paddle wheel mixers and walking beam flocculators; settling basins with tube settlers; rapid filtration at 6 gpm/ft2 through 24 in beds having anthracite, silica and garnet sand; addition of chlorine on top of the filters; addition of hydrofluorisilic acid at the entry to the clear well and caustic post clearwell for pH adjustment. Coagulant addition is automatically paced with flow. Coagulant feed volume is monitored to the rapid mix tank. Operators go through a testing protocol to determine proper coagulant doses whenever there is a change in water quality.

The Van de Water Plant uses water from the Niagara River, which has quality characteristics similar to the Lake Erie water used at the Sturgeon Point Plant. Van de Water is also a conventional facility with processes similar to those at Sturgeon Point. The treatment includes potassium permanaganate for zebra mussel control, in-line rapid mixing for coagulant addition and subsequent addition of a coagulant aid polymer; walking beam flocculators; settling basins with tube settlers; rapid filtration at 6 gpm/sf through 33 in beds having anthracite, silica, and garnet sand; addition of chlorine and hydroflurosilic acid, and caustic added post clearwell for pH control.

The Authority initially chose to change from alum to PACl in 1985 because of difficulty in meeting ESWTR turbidity levels during cold water periods. Treatment with alum was difficult during cold water, low turbidity periods. Further, the Authority wanted to reduce the volume of residuals it produced, as it had become a zero discharge facility during this time.

After changing to PACl, both plants were able to consistently achieve finished turbidities < 0.10 NTU. Residuals' solids concentration increased from 25 to 30 percent solids to 40 percent.

The Authority was able to reduce the coagulant does used from about 33 mg/L alum (dry basis) to about 4 mg/L PACl (Sternpac). The treatment in the plants was moved from sweep-floc conditions to charge neutralization mechanism. The plant personnel rely heavily on zeta-potential in the lab and streaming current in the plant for estimating proper coagulant dose.

In 2001, the Authority changed coagulants. They currently use Sumaclear 750 from Summit Research. This is also a PACl product with about twice the alum oxide as the Sternpac product. The product also contains a polymer. Since changing to this PACl, the Authority has been able to use less product, but still achieve finished turbidities less than 0.1 NTU. The quantity and physical characteristics of the residuals produced has also changed. Less sludge is produced and the product is less dense, making sludge blowdown easier. The plants have decreased the backwash time and rate, finding that more of the floc is released during the low wash stage. They believe that backwashing now produces a cleaner filter than when they were using Sternapc.

The only problems they have experienced have occurred during summer months when small diatoms are in the raw water. During those periods, the coagulant did not work as well. Particle counts increased, and finished turbidities increased to about 0.13 NTU. Treatment was optimized during this period by slightly increasing the coagulant dose at the rapid mix by 1 mg/L, and also adding 0.2 to 0.5 mg/L on top of the filters.

Another problem for treatment occurs when the UV_{254} increases, indicating the presence of colloidal organic material in the raw water. When this occurs, the authority personnel will typically add a coagulant aid polymer (nonionic Nalco or Applied Specialties).

They currently do not adjust the pH prior to coagulation. The raw water pH is typically 8.2. During the summer diatom blooms, they can experience a pH as high as 8.7, but they have not adjusted the pH. A series of pilot studies were conducted on the impact and efficacy of coagulation pH depression. These studies indicated that better organic removal was possible by lowering the pH to 6.5, and even 7.5, but no changes have been made to the treatment in the full scale plants. Mr. Mogavero indicated that based on their IDSE results, they may have to revisit depressing the coagulation pH. After treatment, the pH of the finished water is raised to pH 8 using caustic. No corrosion inhibitor is used.

Mr. Mogavero indicated that no elevated aluminum data have been seen in the distribution system since the switch to PACl. No failure of distribution system materials have been due to the PACl, although in older sections of pipe sometimes a gel is noted. There's no evidence that this material is attributable to PACl.

Typical dose of product is 3 mg/L wet. The highest dose that Mr. Mogavero recalls being fed was 11 mg/L at the Sturgeon Point Plant. This resulted in a feed rate of the PACl of 14 gallons/hr to achieve this coagulant dose for the flow rate that day.

In switching from alum to PACl, the metering pumps had to be changed because the existing pumps were inaccurate for the decreased doses. Delivery pipes were also reduced in size. Some problems were observed with the steel pipes of the chemical feed system. Authority personnel noted leakage around endcaps and determined that the PACl was causing internal corrosion, and subsequently causing pipe failure. Portions of the pump heads were also corroding. The Authority then switched to peristaltic pumps using poly ethylene tubing. They had experienced some success using the Sternpac pumps made of "castalloy", but maintain that the peristaltic system is more reliable. They maintain two sets of the tubing, allowing for changeover with quick disconnects if the feed tube gets clogged. They also found that decreasing the diameter of the tube helped to keep the tubes from clogging, because of the increased velocity.

ECWA recommends that it is important to flush and dry all tanks and piping when converting from alum to PACl. They found that PACl formed precipitates when diluted with tap or raw water. They feel that this is due to the fact that PACl is already partly neutralized, therefore is not as acidic and the pH can be high enough to cause precipitation. Authority personnel also report a gel is formed when alum and PACl are allowed to mix. This gel is very difficult to remove.

The Authority requires that all vendors demonstrate experience in water treatment. The bidding process requires new coagulant candidates perform as well or better than the currently used coagulant. They then choose coagulants based on coagulant dose, filter performance from their pilot facility and residuals volume.

ECWA noted that operators had to be re-trained after the coagulant switch, and the strategies for setting coagulant doses had to be reviewed. For example, they found that chemical feed problems were more critical for charge neutralization and so operators must routinely verify coagulant feed rates. Also, with charge-neutralization operation, operators had to learn to base changes in coagulant dose on streaming current readings rather than on raw water turbidity.

Mr. Mogavero recommended that if a plant was to switch from alum to PACl, acid washing of the filter media should be considered. He feels that if the two products are missed, even after flocculation, there could be clogging issues in the filter media.

APPENDIX B

COST ESTIMATES

1. McMillan WTP, 12 percent sodium hypochlorite, existing building, 18’ dia. tanks (M1)
2. McMillan WTP, 6 percent sodium hypochlorite, new building, 12’ dia. tanks (M2)
3. McMillan WTP, 6 percent sodium hypochlorite, new building, 18’ dia. tanks (M3)
4. McMillan WTP, 12 percent sodium hypochlorite, new building, 12’ dia. tanks (M4)
5. McMillan WTP, 6 percent sodium hypochlorite, slow sand filters, horizontal tanks
6. Dalecarlia WTP, 12 percent sodium hypochlorite, new building, 12’ tanks (D1)
7. Dalecarlia WTP, 12 percent sodium hypochlorite, new building, 25’ tanks (D2)
8. Dalecarlia WTP, 6 percent sodium hypochlorite, new building, 12’ tanks (D3)
9. Dalecarlia WTP, 6 percent sodium hypochlorite, new building, 25’ tanks (D4)
10. McMillan WTP, on-site generation of sodium hypochlorite, existing building
11. Dalecarlia WTP, on-site generation of sodium hypochlorite, new building
12. McMillan WTP, caustic soda and sulfuric acid, existing chlorine room
13. McMillan WTP, caustic soda and sulfuric acid, slow sand filters
14. Dalecarlia WTP, caustic soda and sulfuric acid, existing chlorine room, during construction
15. Dalecarlia WTP, caustic soda and sulfuric acid, existing chlorine room, after construction

Project: McMILLAN SODIUM HYPOCHLORITE FEED PIPING
Sheet No. : ____ of ____

Location: McMILLAN WTP

Project No.
Estimated LaborCost : 30 %

Description: EXISTING BUILDING - 18' DIA. TANKS--BUILD ON SITE TANKS

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: M1 - Drawings — Done By: DR — Date: 06/20/06

12% SODIUM HYPOCHLORITE — Chkd By: DAC — Date: 06/20/06

Existing Building

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000		$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	60	$270.00	$16,200	$130.00	$7,800		$400.00	$24,000
3	CONCRETE CONTAINMENT CURB	CY	20	$270.00	$5,400	$130.00	$2,600		$400.00	$8,000
4	18' FRP SODIUM HYPOCHLORITE TANKS - 35,000 GALLON	EA	4	$70,000.00	$280,000	$90,000.00	$360,000		$160,000.00	$640,000
5	FRP GRATING	SF	2,840	$25.00	$71,000	$10.00	$28,400		$35.00	$99,400
6	FEED PUMPS	EA	5	$19,000.00	$95,000	$6,000.00	$30,000		$25,000.00	$125,000
7	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000		$30,000.00	$150,000
8	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
10	HVAC IMPROVEMENTS	SF	5,000	$2.00	$10,000	$2.00	$10,000		$4.00	$20,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	2,000	$32.00	$64,000	$10.00	$20,000		$42.00	$84,000
13	3" LINED DUCTILE VALVES	EA	8	$725.00	$5,800	$500.00	$4,000		$1,225.00	$9,800
14	2" LINED STEEL PIPING	LF	1,200	$25.00	$30,000	$10.00	$12,000		$35.00	$42,000
15	2" LINED STEEL VALVES	EA	8	$425.00	$3,400	$500.00	$4,000		$925.00	$7,400
16	3" PVC TANK DRAIN	LF	1,200	$5.00	$6,000	$5.00	$6,000		$10.00	$12,000
17	3" PVC TANK DRAIN VALVES	EA	4	$260.00	$1,040	$100.00	$400		$360.00	$1,440
18	8" PVC TANK VENTS	EA	4	$600.00	$2,400	$300.00	$1,200		$900.00	$3,600
19	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
20	LEVEL SENSORS	EA	4	$2,000.00	$8,000	$600.00	$2,400		$2,600.00	$10,400
21										
22										
22	SUB-TOTAL				$729,240		$686,800			$1,416,040
23	5% SALE TAX				$36,462					$36,462
24	50% LABOR BURDEN						$343,400			$343,400
25										
26	SUB-TOTAL				$765,702		$1,030,200			$1,795,902
27	5% SUB BOND & INS (50% of PROJECT)									$44,898
28										
29	SUB-TOTAL									$1,840,800
30	10% SUB O/H (50% of PROJECT)									$92,040
31										
32	SUB-TOTAL									$1,932,840
33	10% SUB PROFIT (50% of PROJECT)									$96,642
34										
35	SUB-TOTAL									$2,029,482
36	5% PRIME BOND AND INS									$101,474
37										
38	SUB-TOTAL									$2,130,956
39	10% PRIME O/H									$213,096
40										
41	SUB-TOTAL									$2,344,051
42	10% PRIME PROFIT									$234,405
43										
44	SUB-TOTAL									$2,578,456
45	5% MOB / DEMOB									$128,923
46										
47	SUB-TOTAL									$2,707,379
48	25% CONTINGENCY									$676,845
49										
50	TOTAL (FEB 2007)									$3,384,224
51										
52	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$3,784,095

Project: McMILLAN SODIUM HYPOCHLORITE FEED PIPING — Sheet No. : ____ of ____

Location: McMILLAN WTP

Project No. — Estimated LaborCost : 30 %

Description: NEW BUILDING - 12' DIA. TANKS--TRUCKED IN TANKS

Design Status: [X] No Design Completed

Remarks: M2 - Drawings — Done By: DR — Date: 06/20/06 — [ ] Preliminary Design

6% SODIUM HYPOCHLORITE — Chkd By: DAC — Date: 06/20/06 — [ ] Final Design

BUILDING HEIGHT - 25'-7" — [ ] Other:

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	13,000	$145.00	$1,885,000	$95.00	$1,235,000		$240.00	$3,120,000
2	HVAC	SF	13,000	$2.00	$26,000	$2.00	$26,000		$4.00	$52,000
3	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$50,000.00	$50,000		$50,000.00	$50,000
4	CONCRETE TANK PADS	CY	130	$270.00	$35,100	$130.00	$16,900		$400.00	$52,000
5	6" CONTAINMENT CURB	CY	10	$270.00	$2,700	$130.00	$1,300		$400.00	$4,000
6	FRP GRATING	SF	9,000	$25.00	$225,000	$10.00	$90,000		$35.00	$315,000
7	12' FRP SODIUM HYPOCHLORITE TANKS - 14,000 GALLON	EA	20	$28,000.00	$560,000	$10,000.00	$200,000		$38,000.00	$760,000
8	FEED PUMPS	EA	5	$19,000.00	$95,000	$6,000.00	$30,000		$25,000.00	$125,000
9	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000		$30,000.00	$150,000
10	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
11	WATER SOFTENERS	EA	4	$12,000.00	$48,000	$3,600.00	$14,400		$15,600.00	$62,400
12	**TANK PIPING**									
13	3" D.I. FL PIPING	LF	5,000	$20.00	$100,000	$14.00	$70,000		$34.00	$170,000
14	3" D.I. FL VALVES	EA	50	$350.00	$17,500	$150.00	$7,500		$500.00	$25,000
15	3" LINED STEEL PIPING	LF	3,450	$32.00	$110,400	$10.00	$34,500		$42.00	$144,900
16	3" LINED DUCTILE VALVES	EA	4	$725.00	$2,900	$500.00	$2,000		$1,225.00	$4,900
17	2" LINED STEEL PIPING	LF	3,450	$25.00	$86,250	$10.00	$34,500		$35.00	$120,750
18	2" LINED DUCTILE VALVES	EA	40	$425.00	$17,000	$500.00	$20,000		$925.00	$37,000
19	3" PVC TANK DRAIN	LF	3,450	$5.00	$17,250	$5.00	$17,250		$10.00	$34,500
20	3" PVC TANK DRAIN VALVES	EA	20	$260.00	$5,200	$100.00	$2,000		$360.00	$7,200
21	8" PVC TANK VENTS	EA	20	$600.00	$12,000	$300.00	$6,000		$900.00	$18,000
22	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
23	LEVEL SENSORS	EA	20	$2,000.00	$40,000	$600.00	$12,000		$2,600.00	$52,000
24	BATCH CONTROLLER (FLOW METER)	EA	4	$2,000.00	$8,000	$500.00	$2,000		$2,500.00	$10,000
25										
25										
26	SUB-TOTAL				$3,424,300		$1,969,350			$5,393,650
27	5% SALE TAX				$171,215					
28	50% LABOR BURDEN						$984,675			
29										
30	SUB-TOTAL				$3,595,515		$2,954,025			$6,549,540
31	5% SUB BOND & INS (50% OF PROJECT)									$163,739
32										
33	SUB-TOTAL									$6,713,279
34	10% SUB O/H (50% OF PROJECT)									$335,664
35										
36	SUB-TOTAL									$7,048,942
37	10% SUB PROFIT (50% OF PROJECT)									$352,447
38										
39	SUB-TOTAL									$7,401,390
40	5% PRIME BOND AND INS									$370,069
41										
42	SUB-TOTAL									$7,771,459
43	10% PRIME O/H									$777,146
44										
45	SUB-TOTAL									$8,548,605
46	10% PRIME PROFIT									$854,860
47										
48	SUB-TOTAL									$9,403,465
49	5% MOB / DEMOB									$470,173
50										
51	SUB-TOTAL									$9,873,639
52	25% CONTINGENCY									$2,468,410
53										
54	TOTAL (FEB 2007)									$12,342,048
55										
56	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$13,800,352

Project: McMILLAN SODIUM HYPOCHLORITE FEED PIPING — Sheet No. : ______ of ______
Location: McMILLAN WTP
Project No. ______ — Estimated LaborCost : 30 %
Description: NEW BUILDING - 18' DIA. TANKS--BUILD ON SITE TANKS

Design Status: [X] No Design Completed

Remarks: **M3 - Drawings** — Done By: DR — Date: **06/20/06** — [ ] Preliminary Design

6% SODIUM HYPOCHLORITE — Chkd By: DAC — Date: **06/20/06** — [ ] Final Design

BUILDING HEIGHT - 25'-7" — [ ] Other:

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	9,500	$145.00	$1,377,500	$95.00	$902,500		$240.00	$2,280,000
2	HVAC	SF	9,500	$2.00	$19,000	$2.00	$19,000		$4.00	$38,000
3	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$50,000.00	$50,000		$50,000.00	$50,000
4	CONCRETE TANK PADS	CY	120	$270.00	$32,400	$130.00	$15,600		$400.00	$48,000
5	6" CONTAINMENT CURB	CY	15	$270.00	$4,050	$130.00	$1,950		$400.00	$6,000
6	FRP GRATING	SF	8,200	$25.00	$205,000	$10.00	$82,000		$35.00	$287,000
7	18' FRP SODIUM HYPOCHLORITE TANKS -	EA	8	$65,000.00	$520,000	$90,000.00	$720,000		$155,000.00	$1,240,000
8	FEED PUMPS	EA	5	$19,000.00	$95,000	$6,000.00	$30,000		$25,000.00	$125,000
9	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000		$30,000.00	$150,000
10	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
11	WATER SOFTENERS	EA	4	$12,000.00	$48,000	$3,600.00	$14,400		$15,600.00	$62,400
11										
12	**TANK PIPING**									
13	3" D.I. FL PIPING	LF	2,680	$20.00	$53,600	$14.00	$37,520		$34.00	$91,120
14	3" D.I. FL VALVES	EA	8	$350.00	$2,800	$150.00	$1,200		$500.00	$4,000
15	3" LINED STEEL PIPING	LF	1,080	$32.00	$34,560	$10.00	$10,800		$42.00	$45,360
16	3" LINED DUCTILE VALVES	EA	16	$725.00	$11,600	$500.00	$8,000		$1,225.00	$19,600
17	2" LINED STEEL PIPING	LF	1,080	$25.00	$27,000	$10.00	$10,800		$35.00	$37,800
18	2" LINED DUCTILE VALVES	EA	16	$425.00	$6,800	$500.00	$8,000		$925.00	$14,800
19	3" PVC TANK DRAIN	LF	1,080	$5.00	$5,400	$5.00	$5,400		$10.00	$10,800
20	3" PVC TANK DRAIN VALVES	EA	8	$260.00	$2,080	$100.00	$800		$360.00	$2,880
21	8" PVC TANK VENTS	EA	8	$600.00	$4,800	$300.00	$2,400		$900.00	$7,200
22	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
23	LEVEL SENSORS	EA	20	$2,000.00	$40,000	$600.00	$12,000		$2,600.00	$52,000
24	BATCH CONTROLLER (FLOW METER)	EA	4	$2,000.00	$8,000	$500.00	$2,000		$2,500.00	$10,000
25										
25										
26										
27										
28	SUB-TOTAL				$2,628,590		$2,032,370			$4,660,960
29	5% SALE TAX				$131,430					
30	50% LABOR BURDEN						$1,016,185			
31										
32	SUB-TOTAL				$2,760,020		$3,048,555			$5,808,575
33	5% SUB BOND & INS (50% OF PROJECT)									$145,214
34										
35	SUB-TOTAL									$5,953,789
36	10% SUB O/H ((50% OF PROJECT)									$297,689
37										
38	SUB-TOTAL									$6,251,478
39	10% SUB PROFIT (50% OF PROJECT)									$312,574
40										
41	SUB-TOTAL									$6,564,052
42	5% PRIME BOND AND INS									$328,203
43										
44	SUB-TOTAL									$6,892,255
45	10% PRIME O/H									$689,225
46										
47	SUB-TOTAL									$7,581,480
48	10% PRIME PROFIT									$758,148
49										
50	SUB-TOTAL									$8,339,628
51	5% MOB / DEMOB									$416,981
52										
53	SUB-TOTAL									$8,756,610
54	25% CONTINGENCY									$2,189,152
55										
56	TOTAL (FEB 2007)									$10,945,762
57										
58	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$12,239,084

Project: McMILLAN SODIUM HYPOCHLORITE FEED PIPING — Sheet No. : ____ of ____
Location: McMILLAN WTP
Project No. — Estimated LaborCost : 30 %
Description: NEW BUILDING - 12' DIA. TANKS--TRUCKED IN TANKS

Design Status: [X] No Design Completed; [ ] Preliminary Design; [ ] Final Design; [ ] Other:

Remarks: **M4 - Drawings** — Done By: DR — Date: **06/20/06**
12% SODIUM HYPOCHLORITE — Chkd By: DAC — Date: **06/20/06**
BUILDING HEIGHT - 25'-7"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	7,700	$145.00	$1,116,500	$95.00	$731,500		$240.00	$1,848,000
2	HVAC	SF	7,700	$2.00	$15,400	$2.00	$15,400		$4.00	$30,800
3	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$50,000.00	$50,000		$50,000.00	$50,000
4	CONCRETE TANK PADS	CY	50	$270.00	$13,500	$130.00	$6,500		$400.00	$20,000
5	CONTAINMENT CURB	CY	10	$270.00	$2,700	$130.00	$1,300		$400.00	$4,000
6	FRP GRATING	SF	7,000	$25.00	$175,000	$10.00	$70,000		$35.00	$245,000
7	12' FRP SODIUM HYPOCHLORITE TANKS - 14,000 GALLON	EA	10	$28,000.00	$280,000	$10,000.00	$100,000		$38,000.00	$380,000
8	FEED PUMPS	EA	5	$19,000.00	$95,000	$6,000.00	$30,000		$25,000.00	$125,000
9	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000		$30,000.00	$150,000
10	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
11	**TANK/FEED PIPING**									
12	3" LINED STEEL PIPING	LF	3,600	$32.00	$115,200	$10.00	$36,000		$42.00	$151,200
13	3" LINED DUCTILE VALVES	EA	20	$725.00	$14,500	$500.00	$10,000		$1,225.00	$24,500
14	2" LINED STEEL PIPING	LF	2,000	$25.00	$50,000	$10.00	$20,000		$35.00	$70,000
15	2" LINED DUCTILE VALVES	EA	20	$425.00	$8,500	$500.00	$10,000		$925.00	$18,500
16	3" PVC TANK DRAIN	LF	3,450	$5.00	$17,250	$5.00	$17,250		$10.00	$34,500
17	3" PVC TANK DRAIN VALVES	EA	10	$260.00	$2,600	$100.00	$1,000		$360.00	$3,600
18	8" PVC TANK VENTS	EA	10	$600.00	$6,000	$300.00	$3,000		$900.00	$9,000
19	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
20	LEVEL SENSORS	EA	10	$2,000.00	$20,000	$600.00	$6,000		$2,600.00	$26,000
21										
22										
23	SUB-TOTAL				$2,063,150		$1,205,950			$3,269,100
24	5% SALE TAX				$103,158					
25	50% LABOR BURDEN						$602,975			
26										
27	SUB-TOTAL				$2,166,308		$1,808,925			$3,975,233
28	5% SUB BOND & INS (50% OF PROJECT)									$99,381
29										
30	SUB-TOTAL									$4,074,613
31	10% SUB O/H (50% OF PROJECT)									$203,731
32										
33	SUB-TOTAL									$4,278,344
34	10% SUB PROFIT (50% OF PROJECT)									$213,917
35										
36	SUB-TOTAL									$4,492,261
37	5% PRIME BOND AND INS									$224,613
38										
39	SUB-TOTAL									$4,716,874
40	10% PRIME O/H									$471,687
41										
42	SUB-TOTAL									$5,188,562
43	10% PRIME PROFIT									$518,856
44										
45	SUB-TOTAL									$5,707,418
46	5% MOB / DEMOB									$285,371
47										
48	SUB-TOTAL									$5,992,789
49	25% CONTINGENCY									$1,498,197
50										
51	TOTAL (FEB 2007)									$7,490,986
52										
53	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$8,376,101

Environmental Engineering and Technology, Inc.

Project: McMILLAN SODIUM HYPOCHLORITE STORAGE AND FEED PIPING
Sheet No. : ______ of ______
Location: McMILLAN WTP
Project No.
Estimated LaborCost : 30 %
Description: Slow Sand Filter Building Storage Facility

Design Status: [X] No Design Completed
[ ] Preliminary Design
[ ] Final Design
[ ] Other:

Remarks: Utilize Existing Slow Sand Filter
Done By: DR Date: 07/20/06
Chkd By: DAC Date: 07/20/06

6% SODIUM HYPOCHLORITE
no modification to Filter access --assume existing is used.
does not include structural or foundation improvements,leak repair etc

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST	TOTAL UNIT COST	TOTAL COST
1	MODIFY SLOW SAND BUILDING--ROOF, ETC	SF							
2	HVAC--Ventilation Primarily	SF	98,000	$1.50	$147,000	$1.50	$147,000	3.00	$294,000
3	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000	100,000.00	$100,000
4	CONCRETE TANK SUPPORTS	CY	65	$270.00	$17,550	$270.00	$17,550	540.00	$35,100
5	CONTAINMENT CURB	CY	30	$270.00	$8,100	$270.00	$8,100	540.00	$16,200
6	FRP GRATING	SF	15,000	$25.00	$375,000	$25.00	$375,000	50.00	$750,000
7	HORIZ SODIUM HYPOCHLORITE TANKS (6'x18')	EA	74	$15,000.00	$1,110,000	$15,000.00	$1,110,000	30,000.00	$2,220,000
8	FEED PUMPS	EA	5	$19,000.00	$95,000	$19,000.00	$95,000	38,000.00	$190,000
9	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000	30,000.00	$150,000
10	SCADA CONTROL CABLE AND CONDUIT	LF	2,500	$5.00	$12,500	$5.00	$12,500	10.00	$25,000
11	FILL CONCRETE	CY	1,500	$200.00	$300,000	$200.00	$300,000	400.00	$600,000
12	RAMP	CY	1,000	$200.00	$200,000	$200.00	$200,000	400.00	$400,000
13	STRUCTURAL	LS							
14	WATER SOFTENER	EA	4	$12,000.00	$48,000	$3,600.00	$14,400	15,600.00	$62,400
15									
16	**TANK PIPING**								
17	3" D.I. FL PIPING	LF	1,600	$20.00	$32,000	$20.00	$32,000	40.00	$64,000
18	3" D.I. FL VALVES	EA	74	$350.00	$25,900	$350.00	$25,900	700.00	$51,800
19	3" LINED STEEL PIPING	LF	1,600	$32.00	$51,200	$32.00	$51,200	64.00	$102,400
20	3" LINED DUCTILE VALVES	EA	148	$725.00	$107,300	$725.00	$107,300	1,450.00	$214,600
21	2" LINED STEEL PIPING	LF	1,000	$25.00	$25,000	$25.00	$25,000	50.00	$50,000
22	2" LINED DUCTILE VALVES	EA	148	$425.00	$62,900	$425.00	$62,900	850.00	$125,800
23	3" PVC TANK DRAIN	LF	1,800	$5.00	$9,000	$5.00	$9,000	10.00	$18,000
24	3" PVC TANK DRAIN VALVES	EA	74	$260.00	$19,240	$260.00	$19,240	520.00	$38,480
25	8" PVC TANK VENTS	EA	74	$1,200.00	$88,800	$1,200.00	$88,800	2,400.00	$177,600
26	FLOW METERS	EA	6	$8,500.00	$51,000	$8,500.00	$51,000	17,000.00	$102,000
27	LEVEL SENSORS	EA	74	$2,000.00	$148,000	$2,000.00	$148,000	4,000.00	$296,000
28	BATCH CONTROLLER (FLOW METER)	EA	4	$1,400.00	$5,600	$1,400.00	$5,600	2,800.00	$11,200
29									
25									
26									
27									
28	SUB-TOTAL				$3,014,090		$3,080,490		$6,094,580
29	5% SALE TAX				$150,705				
30	50% LABOR BURDEN						$1,540,245		
31									
32	SUB-TOTAL				$3,164,795		$4,620,735		$7,785,530
33	5% SUB BOND & INS (50% OF PROJECT)								$194,638
34									
35	SUB-TOTAL								$7,980,168
36	10% SUB O/H ((50% OF PROJECT)								$399,008
37									
38	SUB-TOTAL								$8,379,176
39	10% SUB PROFIT (50% OF PROJECT)								$418,959
40									
41	SUB-TOTAL								$8,798,135
42	5% PRIME BOND AND INS								$439,907
43									
44	SUB-TOTAL								$9,238,042
45	10% PRIME O/H								$923,804
46									
47	SUB-TOTAL								$10,161,846
48	10% PRIME PROFIT								$1,016,185
49									
50	SUB-TOTAL								$11,178,030
51	5% MOB / DEMOB								$558,902
52									
53	SUB-TOTAL								$11,736,932
54	25% CONTINGENCY								$2,934,233
55									
56	TOTAL								$14,671,165
57									
58	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)								$16,404,670

Project: DALECARLIA SODIUM HYPOCHLORITE — Sheet No. : ____ of ____
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 12' DIA. TANKS--TRUCKED IN TANKS

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: **D1 - Drawings** — Done By: DR — Date: 06/20/06
12% SODIUM HYPOCHLOLRITE — Chkd By: DAC — Date: 06/20/06
BUILDING HEIGHT - 34'-6"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	10,500	$150.00	$1,575,000	$100.00	$1,050,000		$250.00	$2,625,000
2	HVAC	SF	10,500	$2.00	$21,000	$2.00	$42,000		$4.00	$42,000
3	CONCRETE TANK PADS	CY	94	$270.00	$25,380	$130.00	$12,220		$400.00	$37,600
4	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
5	FRP GRATING	SF	7,200	$25.00	$180,000	$10.00	$72,000		$35.00	$252,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	15	$40,000.00	$600,000	$12,000.00	$180,000		$52,000.00	$780,000
7	FEED PUMPS	EA	9	$20,000.00	$180,000	$6,000.00	$54,000		$26,000.00	$234,000
8	PUMP CONTROL	EA	9	$15,000.00	$135,000	$15,000.00	$135,000		$30,000.00	$270,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	2,130	$32.00	$68,160	$10.00	$21,300		$42.00	$89,460
13	3" LINED DUCTILE VALVES	EA	30	$725.00	$21,750	$500.00	$15,000		$1,225.00	$36,750
14	2" LINED STEEL PIPING	LF	2,130	$25.00	$53,250	$10.00	$21,300		$35.00	$74,550
15	2" LINED STEEL VALVES	EA	30	$425.00	$12,750	$500.00	$15,000		$925.00	$27,750
16	3" PVC TANK DRAIN	LF	2,130	$5.00	$10,650	$5.00	$10,650		$10.00	$21,300
17	3" PVC TANK DRAIN VALVES	EA	15	$260.00	$3,900	$100.00	$1,500		$360.00	$5,400
18	8" PVC TANK VENTS	EA	15	$600.00	$9,000	$300.00	$4,500		$900.00	$13,500
19	FLOW METERS	EA	7	$8,500.00	$59,500	$3,000.00	$21,000		$11,500.00	$80,500
20	LEVEL SENSORS	EA	15	$2,000.00	$30,000	$600.00	$9,000		$2,600.00	$39,000
21	**DISTRIBUTION PIPING**									
22	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
23	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
24	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
25	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
26	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
27	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
28	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
29	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
30	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
31	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
32	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
33										
34										
35	SUB-TOTAL				$3,021,155		$1,771,141			$4,792,296
36	5% SALE TAX				$151,058					
37	50% LABOR BURDEN						$885,570			
38										
39	SUB-TOTAL				$3,172,213		$2,656,711			$5,828,924
40	5% SUB BOND & INS (50% OF PROJECT)									$145,723
41										
42	SUB-TOTAL									$5,974,647
43	10% SUB O/H (50% OF PROJECT)									$298,732
44										
45	SUB-TOTAL									$6,273,379
46	10% SUB PROFIT (50% OF PROJECT)									$313,669
47										
48	SUB-TOTAL									$6,587,048
49	5% PRIME BOND AND INS									$329,352
50										
51	SUB-TOTAL									$6,916,400
52	10% PRIME O/H									$691,640
53										
54	SUB-TOTAL									$7,608,040
55	10% PRIME PROFIT									$760,804
56										
57	SUB-TOTAL									$8,368,845
58	5% MOB / DEMOB									$418,442
59										
60	SUB-TOTAL									$8,787,287
61	25% CONTINGENCY									$2,196,822
62										
63	TOTAL									$10,984,108
64										
65	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$12,281,961

Project: DALECARLIA SODIUM HYPOCHLORITE — Sheet No. : ____ of ____
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 25' DIA. TANKS--BUILD ON SITE TANKS

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: D2 - Drawings — Done By: DR — Date: 06/20/06
12% SODIUM HYPOCHLOLRITE — Chkd By: DAC — Date: 06/20/06
BUILDING HEIGHT - 34'-11"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	10,000	$150.00	$1,500,000	$100.00	$1,000,000		$250.00	$2,500,000
2	HVAC	SF	10,000	$2.00	$20,000	$2.00	$20,000		$4.00	$40,000
3	CONCRETE TANK PADS	CY	200	$270.00	$54,000	$130.00	$26,000		$400.00	$80,000
4	CONCRETE CONTAINMENT CURB	CY	20	$270.00	$5,400	$130.00	$2,600		$400.00	$8,000
5	FRP GRATING	SF	7,000	$25.00	$175,000	$10.00	$70,000		$35.00	$245,000
6	25' FRP SODIUM HYPOCHLORITE TANKS - 50,000 GALLON	EA	6	$100,000.00	$600,000	$100,000.00	$600,000		$200,000.00	$1,200,000
7	FEED PUMPS	EA	9	$20,000.00	$180,000	$6,000.00	$54,000		$26,000.00	$234,000
8	PUMP CONTROL	EA	9	$15,000.00	$135,000	$15,000.00	$135,000		$30,000.00	$270,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	800	$32.00	$25,600	$10.00	$8,000		$42.00	$33,600
13	3" LINED DUCTILE VALVES	EA	12	$725.00	$8,700	$500.00	$6,000		$1,225.00	$14,700
14	2" LINED STEEL PIPING	LF	800	$25.00	$20,000	$10.00	$8,000		$35.00	$28,000
15	2" LINED DUCTILE VALVES	EA	12	$425.00	$5,100	$500.00	$6,000		$925.00	$11,100
16	3" PVC TANK DRAIN	LF	800	$5.00	$4,000	$5.00	$4,000		$10.00	$8,000
17	3" PVC TANK DRAIN VALVES	EA	6	$260.00	$1,560	$100.00	$600		$360.00	$2,160
18	8" PVC TANK VENTS	EA	6	$600.00	$3,600	$300.00	$1,800		$900.00	$5,400
19	FLOW METERS	EA	7	$8,500.00	$59,500	$3,000.00	$21,000		$11,500.00	$80,500
20	LEVEL SENSORS	EA	6	$2,000.00	$12,000	$600.00	$3,600		$2,600.00	$15,600
1	**DISTRIBUTION PIPING**									
2	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
3	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
4	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
5	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
6	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
7	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
8	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
9	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
10	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
11	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
12	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
21										
21										
22	SUB-TOTAL				$2,843,115		$2,072,231			$4,915,346
23	5% SALE TAX				$142,156					
24	50% LABOR BURDEN						$1,036,115			
25										
26	SUB-TOTAL				$2,985,271		$3,108,346			$6,093,617
27	5% SUB BOND & INS (50% OF PROJECT)									$152,340
28										
29	SUB-TOTAL									$6,245,957
30	10% SUB O/H (50% OF PROJECT)									$312,298
31										
32	SUB-TOTAL									$6,558,255
33	10% SUB PROFIT (50% OF PROJECT)									$327,913
34										
35	SUB-TOTAL									$6,886,168
36	5% PRIME BOND AND INS									$344,308
37										
38	SUB-TOTAL									$7,230,476
39	10% PRIME O/H									$723,048
40										
41	SUB-TOTAL									$7,953,524
42	10% PRIME PROFIT									$795,352
43										
44	SUB-TOTAL									$8,748,876
45	5% MOB / DEMOB									$437,444
46										
47	SUB-TOTAL									$9,186,320
48	25% CONTINGENCY									$2,296,580
49										
50	TOTAL									$11,482,900
51										
52	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$12,839,688

Environmental Engineering and Technology, Inc.

Project: DALECARLIA SODIUM HYPOCHLORITE — Sheet No. : ______ of ______
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 12' DIA. TANKS--TRUCKED IN TANKS

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: D3 - Drawings — Done By: DR — Date: 06/20/06
6% SODIUM HYPOCHLOLRITE — Chkd By: DAC — Date: 06/20/06
BUILDING HEIGHT - 34'-11"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	19,000	$150.00	$2,850,000	$100.00	$1,900,000		$250.00	$4,750,000
2	HVAC	SF	19,000	$2.00	$38,000	$2.00	$38,000		$4.00	$76,000
3	CONCRETE TANK PADS	CY	200	$270.00	$54,000	$130.00	$26,000		$400.00	$80,000
4	CONCRETE CONTAINMENT CURB	CY	10	$270.00	$2,700	$130.00	$1,300		$400.00	$4,000
5	FRP GRATING	SF	16,000	$25.00	$400,000	$10.00	$160,000		$35.00	$560,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	30	$40,000.00	$1,200,000	$12,000.00	$360,000		$52,000.00	$1,560,000
7	FEED PUMPS	EA	9	$20,000.00	$180,000	$6,000.00	$54,000		$26,000.00	$234,000
8	PUMP CONTROL	EA	9	$15,000.00	$135,000	$15,000.00	$135,000		$30,000.00	$270,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$50,000.00	$50,000		$50,000.00	$50,000
11	WATER SOFTENERS	EA	4	$12,000.00	$48,000	$3,600.00	$14,400		$15,600.00	$62,400
12	**TANK PIPING**									
11	3" D.I. FL DILUTION WATER PIPING	LF	2,000	$20.00	$40,000	$14.00	$28,000		$34.00	$68,000
12	3" D.I. FL DILUTION WATER VALVES	EA	30	$350.00	$10,500	$150.00	$4,500		$500.00	$15,000
13	3" LINED STEEL PIPING	LF	4,000	$32.00	$128,000	$10.00	$40,000		$42.00	$168,000
14	3" LINED DUCTILE VALVES	EA	60	$725.00	$43,500	$500.00	$30,000		$1,225.00	$73,500
15	2" LINED STEEL PIPING	LF	4,000	$25.00	$100,000	$10.00	$40,000		$35.00	$140,000
16	2" LINED DUCTILE VALVES	EA	60	$425.00	$25,500	$500.00	$30,000		$925.00	$55,500
17	3" PVC TANK DRAIN	LF	4,000	$5.00	$20,000	$5.00	$20,000		$10.00	$40,000
18	3" PVC TANK DRAIN VALVES	EA	30	$260.00	$7,800	$100.00	$3,000		$360.00	$10,800
19	8" PVC TANK VENTS	EA	30	$600.00	$18,000	$300.00	$9,000		$900.00	$27,000
20	FLOW METERS	EA	7	$8,500.00	$59,500	$3,000.00	$21,000		$11,500.00	$80,500
21	LEVEL SENSORS	EA	30	$2,000.00	$60,000	$600.00	$18,000		$2,600.00	$78,000
22	BATCH CONTROLLER (FLOW METER)	EA	4	$2,000.00	$8,000	$500.00	$2,000		$2,500.00	$10,000
23	**DISTRIBUTION PIPING**									
24	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
25	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
26	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
27	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
28	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
29	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
30	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
31	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
32	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
33	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
34	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
35										
36										
37	SUB-TOTAL				$5,462,155		$3,039,831			$8,501,986
38	5% SALE TAX				$273,108					
39	50% LABOR BURDEN						$1,519,915			
40										
41	SUB-TOTAL				$5,735,263		$4,559,746			$10,295,009
42	5% SUB BOND & INS (50% OF PROJECT)									$257,375
43										
44	SUB-TOTAL									$10,552,384
45	10% SUB O/H (50% OF PROJECT)									$527,619
46										
47	SUB-TOTAL									$11,080,003
48	10% SUB PROFIT (50% OF PROJECT)									$554,000
49										
50	SUB-TOTAL									$11,634,003
51	5% PRIME BOND AND INS									$581,700
52										
53	SUB-TOTAL									$12,215,703
54	10% PRIME O/H									$1,221,570
55										
56	SUB-TOTAL									$13,437,274
57	10% PRIME PROFIT									$1,343,727
58										
59	SUB-TOTAL									$14,781,001
60	5% MOB / DEMOB									$739,050
61										
62	SUB-TOTAL									$15,520,051
63	25% CONTINGENCY									$3,880,013
64										
65	TOTAL (FEB 2007)									$19,400,064
66										
67	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$21,692,323

Project: DALECARLIA SODIUM HYPOCHLORITE Sheet No. : ______ of ______
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 25' DIA. TANKS---BUILD ON SITE TANKS

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: D4 - Drawings Done By: DR Date: 06/20/06

6% SODIUM HYPOCHLOLRITE Chkd By: DAC Date: 06/20/06

BUILDING HEIGHT - 34'-11"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	18,500	$150.00	$2,775,000	$100.00	$1,850,000		$250.00	$4,625,000
2	HVAC	SF	18,500	$2.00	$37,000	$2.00	$37,000		$4.00	$74,000
3	CONCRETE TANK PADS	CY	300	$270.00	$81,000	$130.00	$39,000		$400.00	$120,000
4	CONCRETE CONTAINMENT CURB	CY	17	$270.00	$4,590	$130.00	$2,210		$400.00	$6,800
5	FRP GRATING	SF	10,000	$25.00	$250,000	$10.00	$100,000		$35.00	$350,000
6	25' FRP SODIUM HYPOCHLORITE TANKS - 50,000 GALLON	EA	12	$100,000.00	$1,200,000	$100,000.00	$1,200,000		$200,000.00	$2,400,000
7	FEED PUMPS	EA	9	$20,000.00	$180,000	$6,000.00	$54,000		$26,000.00	$234,000
8	PUMP CONTROL	EA	9	$15,000.00	$135,000	$15,000.00	$135,000		$30,000.00	$270,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1		$0	$50,000.00	$50,000		$50,000.00	$50,000
11	WATER SOFTENERS	EA	4	$12,000.00	$48,000	$3,600.00	$14,400		$15,600.00	$62,400
12	**TANK PIPING**									
13	3" D.I. FL DILUTION WATER PIPING	LF	500	$20.00	$10,000	$14.00	$7,000		$34.00	$17,000
14	3" D.I. FL DILUTION WATER VALVES	EA	12	$350.00	$4,200	$150.00	$1,800		$500.00	$6,000
15	3" LINED STEEL PIPING	LF	1,500	$32.00	$48,000	$10.00	$15,000		$42.00	$63,000
16	3" LINED DUCTILE VALVES	EA	24	$725.00	$17,400	$500.00	$12,000		$1,225.00	$29,400
17	2" LINED STEEL PIPING	LF	1,500	$25.00	$37,500	$10.00	$15,000		$35.00	$52,500
18	2" LINED DUCTILE VALVES	EA	24	$425.00	$10,200	$500.00	$12,000		$925.00	$22,200
19	3" PVC TANK DRAIN	LF	1,500	$5.00	$7,500	$5.00	$7,500		$10.00	$15,000
20	3" PVC TANK DRAIN VALVES	EA	12	$260.00	$3,120	$100.00	$1,200		$360.00	$4,320
21	8" PVC TANK VENTS	EA	12	$600.00	$7,200	$300.00	$3,600		$900.00	$10,800
22	FLOW METERS	EA	7	$8,500.00	$59,500	$3,000.00	$21,000		$11,500.00	$80,500
23	LEVEL SENSORS	EA	12	$2,000.00	$24,000	$600.00	$7,200		$2,600.00	$31,200
24	BATCH CONTROLLER (FLOW METER)	EA	4	$2,000.00	$8,000	$500.00	$2,000		$2,500.00	$10,000
25	**DISTRIBUTION PIPING**									
26	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
27	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
28	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
29	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
30	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
31	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
32	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
33	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
34	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
35	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
36	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
37										
38	SUB-TOTAL				$4,980,865		$3,642,541			$8,623,406
39	5% SALE TAX				$249,043					
40	50% LABOR BURDEN						$1,821,270			
41										
42	SUB-TOTAL				$5,229,908		$5,463,811			$10,693,719
43	5% SUB BOND & INS (50% OF PROJECT)									$267,343
44										
45	SUB-TOTAL									$10,961,062
46	10% SUB O/H (50% OF PROJECT)									$548,053
47										
48	SUB-TOTAL									$11,509,115
49	10% SUB PROFIT (50% OF PROJECT)									$575,456
50										
51	SUB-TOTAL									$12,084,571
52	5% PRIME BOND AND INS									$604,229
53										
54	SUB-TOTAL									$12,688,800
55	10% PRIME O/H									$1,268,880
56										
57	SUB-TOTAL									$13,957,680
58	10% PRIME PROFIT									$1,395,768
59										
60	SUB-TOTAL									$15,353,447
61	5% MOB / DEMOB									$767,672
62										
63	SUB-TOTAL									$16,121,120
64	25% CONTINGENCY									$4,030,280
65										
66	TOTAL (FEB 2007)									$20,151,400
67										
68	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$22,532,435

Environmental Engineering and Technology, Inc.

Project: **McMILLAN SODIUM HYPOCHLORITE** Sheet No. : ________ of ________

Location: **McMILLAN WTP**

Project No. Estimated LaborCost : 30 %

Description: **EXISTING BUILDING - 12' DIA. TANKS--TRUCKED TANKS**

Design Status: [X] No Design Completed

Remarks: **M5 - Drawings** Done By: WG Date: 07/12/06 [ ] Preliminary Design

ON-SITE GENERATION Chkd By: DR Date: 07/12/06 [ ] Final Design

[ ] Other:

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000		$ 100,000.00	$100,000
2	CONCRETE TANK PADS	CY	55	$270.00	$14,850	$130.00	$7,150		$ 400.00	$22,000
3	CONCRETE CONTAINMENT CURB	CY	3	$270.00	$810	$130.00	$390		$ 400.00	$1,200
4	12' FRP SODIUM HYPOCHLORITE TANKS - 15,000 GALLON	EA	6	$28,000.00	$168,000	$10,000.00	$60,000		$ 38,000.00	$228,000
5	FRP GRATING	SF	2,840	$25.00	$71,000	$10.00	$28,400		$ 35.00	$99,400
6	FEED PUMPS	EA	5	$19,000.00	$95,000	$6,000.00	$30,000		$ 25,000.00	$125,000
7	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000		$ 30,000.00	$150,000
8	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$ 10.00	$10,000
9	TEMPORARY FEED PUMPS	LS	1	$50,000.00	$50,000	$50,000.00	$50,000		$ 100,000.00	$100,000
10	ELECTRICAL	SF	5,000	$4.00	$20,000	$4.00	$20,000		$ 8.00	$40,000
11	ON-SITE GENERATION EQUIPMENT (ESTIMATE)	EA	1	$1,300,000.00	$1,300,000	$390,000.00	$390,000		$ 1,690,000.00	$1,690,000
12	BACK-UP GENERATOR (1500 kW)	EA	1	$200,000.00	$200,000	$200,000.00	$200,000		$ 400,000.00	$400,000
13	AUTOMATIC TRANSFER SWITCH (2000A)	EA	1	$27,000.00	$27,000	$27,000.00	$27,000		$ 54,000.00	$54,000
14	ELECTRICAL SERVICE UPGRADES	LS	1	$219,000.00	$219,000	$75,000.00	$75,000		$ 294,000.00	$294,000
15	**TANK PIPING**									
16	3" LINED STEEL PIPING	LF	1,200	$32.00	$38,400	$10.00	$12,000		$ 42.00	$50,400
17	3" LINED DUCTILE VALVES	EA	6	$725.00	$4,350	$500.00	$3,000		$ 1,225.00	$7,350
18	2" LINED STEEL PIPING	LF	1,200	$25.00	$30,000	$10.00	$12,000		$ 35.00	$42,000
19	2" LINED STEEL VALVES	EA	12	$425.00	$5,100	$500.00	$6,000		$ 925.00	$11,100
20	3" PVC TANK DRAIN	LF	1,200	$5.00	$6,000	$5.00	$6,000		$ 10.00	$12,000
21	3" PVC TANK DRAIN VALVES	EA	6	$260.00	$1,560	$100.00	$600		$ 360.00	$2,160
22	8" PVC TANK VENTS	EA	6	$600.00	$3,600	$300.00	$1,800		$ 900.00	$5,400
23	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$ 11,500.00	$69,000
24	LEVEL SENSORS	EA	6	$2,000.00	$12,000	$600.00	$3,600		$ 2,600.00	$15,600
25										
26	**FEED PIPING**									
27	3" FEED PIPING TO EXISTING FEED LINES (3 LINES x 400 FT)	LF	1,200	$32.00	$38,400	$10.00	$12,000		$ 42.00	$50,400
28										
29										
30	SUB-TOTAL				$2,436,070		$1,142,940			$3,579,010
31	5% SALE TAX				$121,804					$121,804
32	50% LABOR BURDEN						$571,470			$571,470
33										
34	SUB-TOTAL				$2,557,874		$1,714,410			$4,272,284
35	5% SUB BOND & INS (50% of PROJECT)									$106,807
36										
37	SUB-TOTAL									$4,379,091
38	10% SUB O/H (50% of PROJECT)									$218,955
39										
40	SUB-TOTAL									$4,598,045
41	10% SUB PROFIT (50% of PROJECT)									$229,902
42										
43	SUB-TOTAL									$4,827,947
44	5% PRIME BOND AND INS									$241,397
45										
46	SUB-TOTAL									$5,069,345
47	10% PRIME O/H									$506,934
48										
49	SUB-TOTAL									$5,576,279
50	10% PRIME PROFIT									$557,628
51										
52	SUB-TOTAL									$6,133,907
53	5% MOB / DEMOB									$306,695
54										
55	SUB-TOTAL									$6,440,602
56	25% CONTINGENCY									$1,610,151
57										
58	TOTAL (FEB 2007)									$8,050,753
59										
60	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$8,958,403

Environmental Engineering and Technology, Inc.

Project: DALECARLIA SODIUM HYPOCHLORITE — Sheet No. : ______ of ______
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 25' DIA. TANKS---BUILD ON SITE TANKS

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: **D5 - Drawings** — Done By: WG — Date: 07/12/06
On-Site Generation — Chkd By: DR — Date: 07/12/06
building height - 26'

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST	TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	9,650	$145.00	$1,399,250	$95.00	$916,750	$ 240.00	$2,316,000
2	ELECTRIC	SF	9,650	$4.00	$38,600	$4.00	$38,600	$ 8.00	$77,200
3	CONCRETE TANK PADS	CY	100	$270.00	$27,000	$130.00	$13,000	$ 400.00	$40,000
4	CONCRETE CONTAINMENT CURB	CY	22	$270.00	$5,940	$130.00	$2,860	$ 400.00	$8,800
5	FRP GRATING	SF	5,200	$25.00	$130,000	$10.00	$52,000	$ 35.00	$182,000
6	25' FRP SODIUM HYPOCHLORITE TANKS - 50,000 GALLON	EA	3	$100,000.00	$300,000	$100,000.00	$300,000	$ 200,000.00	$600,000
7	FEED PUMPS	EA	9	$20,000.00	$180,000	$6,000.00	$54,000	$ 26,000.00	$234,000
8	PUMP CONTROL	EA	9	$15,000.00	$135,000	$15,000.00	$135,000	$ 30,000.00	$270,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500	$ 10.00	$9,000
10	ON-SITE GENERATION EQUIPMENT (ESTIMATE)	EA	1	$2,150,000.00	$2,150,000	$645,000.00	$645,000	$ 2,795,000.00	$2,795,000
11	BACK-UP GENERATOR (2,250 kW)	EA	1	$350,000.00	$350,000	$350,000.00	$350,000	$ 700,000.00	$700,000
12	AUTOMATIC TRANSFER SWITCH (3000A)	EA	1	$44,000.00	$44,000	$44,000.00	$44,000	$ 88,000.00	$88,000
13	ELECTRICAL SERVICE UPGRADE	LS	1	$361,000.00	$361,000	$137,000.00	$137,000	$ 498,000.00	$498,000
14	**TANK PIPING**								
15	4" LINED STEEL PIPING	LF	500	$45.00	$22,500	$10.00	$5,000	$ 55.00	$27,500
16	4" LINED DUCTILE VALVES	EA	6	$1,000.00	$6,000	$500.00	$3,000	$ 1,500.00	$9,000
17	3" LINED STEEL PIPING	LF	500	$32.00	$16,000	$10.00	$5,000	$ 42.00	$21,000
18	3" LINED DUCTILE VALVES	EA	6	$725.00	$4,350	$500.00	$3,000	$ 1,225.00	$7,350
19	4" PVC TANK DRAIN	LF	500	$8.00	$4,000	$5.00	$2,500	$ 13.00	$6,500
20	4" PVC TANK DRAIN VALVES	EA	3	$350.00	$1,050	$100.00	$300	$ 450.00	$1,350
21	8" PVC TANK VENTS	EA	3	$600.00	$1,800	$300.00	$900	$ 900.00	$2,700
22	FLOW METERS	EA	7	$8,500.00	$59,500	$3,000.00	$21,000	$ 11,500.00	$80,500
23	LEVEL SENSORS	EA	3	$2,000.00	$6,000	$600.00	$1,800	$ 2,600.00	$7,800
24	**TRANSFER PIPING**								
25	3" LINED STEELTRANSFER PIPING (5 LINES X 500 FT)	LF	2,500	$32.00	$80,000	$10.00	$25,000	$ 42.00	$105,000
26	EXCAVATION AND BACKFILL (400 FT)	CY	200	$25.00	$5,000	$5.00	$1,000	$ 30.00	$6,000
27	CONCRETE PIPE TRENCH (400 FT)	LF	400	$125.00	$50,000	$50.00	$20,000	$ 175.00	$70,000
28									
29									
30	SUB-TOTAL				$5,381,490		$2,781,210		$8,162,700
31	5% SALE TAX				$269,075				
32	50% LABOR BURDEN						$1,390,605		
33									
34	SUB-TOTAL				$5,650,565		$4,171,815		$9,822,380
35	5% SUB BOND & INS (50% OF PROJECT)								$245,559
36									
37	SUB-TOTAL								$10,067,939
38	10% SUB O/H (50% OF PROJECT)								$503,397
39									
40	SUB-TOTAL								$10,571,336
41	10% SUB PROFIT (50% OF PROJECT)								$528,567
42									
43	SUB-TOTAL								$11,099,903
44	5% PRIME BOND AND INS								$554,995
45									
46	SUB-TOTAL								$11,654,898
47	10% PRIME O/H								$1,165,490
48									
49	SUB-TOTAL								$12,820,388
50	10% PRIME PROFIT								$1,282,039
51									
52	SUB-TOTAL								$14,102,426
53	5% MOB / DEMOB								$705,121
54									
55	SUB-TOTAL								$14,807,548
56	25% CONTINGENCY								$3,701,887
57									
58	TOTAL (FEB 2007)								$18,509,435
59									
60	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)								$20,596,207

Project: Sodium Hypochlorite Study — Sheet No. : ______ of ______
Location: McMillan WTP
Project No.
Description: Convert Existing Chlorine Storage Room into Caustic and S. Acid Room

Design Status: [X] No Design Completed [ ] Preliminary Design [ ] Final Design [ ] Other:

Remarks: **Figure 5.5** — Done By: ______ Date: ______

Sulfuric Acid and Caustic Soda are used for final pH adjustment — Chkd By: ______ Date: ______
Target storage of 24,000 gal Caustic and 5,000 gal S. Acid

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
	CHLORINE FACILITY AREA CONVERSION									
1	DEMO EXISTING (REMOVE Cl2 MANIFOLDS, ETC.)	LS	1	$0.00	$0	$100,000.00	$100,000		$100,000.00	$100,000
2	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
3										
4	**CAUSTIC SODA**									
5	7' FRP CAUSTIC SODA TANKS - 3,000 GALLON	EA	8	$10,000.00	$80,000	$4,000.00	$32,000		$14,000.00	$112,000
6	LEVEL SENSORS	EA	8	$2,000.00	$16,000	$600.00	$4,800		$2,600.00	$20,800
7	8" PVC TANK VENTS	EA	8	$600.00	$4,800	$300.00	$2,400		$900.00	$7,200
8	3" PVC TANK DRAIN VALVES	EA	8	$260.00	$2,080	$100.00	$800		$360.00	$2,880
9	2" FILL LINES	LF	200	$22.00	$4,400	$22.00	$4,400		$44.00	$8,800
10	2" FILL VALVES	EA	2	$500.00	$1,000	$250.00	$500		$750.00	$1,500
11	FEED PUMPS	EA	3	$20,000.00	$60,000	$6,000.00	$18,000		$26,000.00	$78,000
12	FLOW METERS	EA	3	$8,500.00	$25,500	$3,000.00	$9,000		$11,500.00	$34,500
13	PUMP CONTROL	EA	3	$15,000.00	$45,000	$15,000.00	$45,000		$30,000.00	$90,000
14	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250		$10.00	$4,500
15	3" LINED STEEL TANK PIPING	LF	1,000	$32.00	$32,000	$10.00	$10,000		$42.00	$42,000
16	3" LINED DUCTILE VALVES	EA	24	$725.00	$17,400	$500.00	$12,000		$1,225.00	$29,400
17	1" LINED STEEL FEED PIPING	LF	1,000	$25.00	$25,000	$5.00	$5,000		$30.00	$30,000
18										
19	**SULFURIC ACID**									
20	7' STEEL ACID TANKS - 3,000 GALLON	EA	2	$14,000.00	$28,000	$10,000.00	$20,000		$24,000.00	$48,000
21	LEVEL SENSORS	EA	2	$2,000.00	$4,000	$600.00	$1,200		$2,600.00	$5,200
22	8" PVC TANK VENTS	EA	2	$600.00	$1,200	$300.00	$600		$900.00	$1,800
23	3" PVC TANK DRAIN VALVES	EA	2	$260.00	$520	$100.00	$200		$360.00	$720
24	2" FILL LINES	LF	100	$22.00	$2,200	$22.00	$2,200		$44.00	$4,400
25	2" FILL VALVES	EA	2	$500.00	$1,000	$250.00	$500		$750.00	$1,500
26	FEED PUMPS	EA	2	$20,000.00	$40,000	$6,000.00	$12,000		$26,000.00	$52,000
27	FLOW METERS	EA	2	$8,500.00	$17,000	$3,000.00	$6,000		$11,500.00	$23,000
28	PUMP CONTROL	EA	2	$15,000.00	$30,000	$15,000.00	$30,000		$30,000.00	$60,000
29	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250		$10.00	$4,500
30	3" LINED STEEL TANK PIPING	LF	300	$32.00	$9,600	$10.00	$3,000		$42.00	$12,600
31	3" LINED DUCTILE VALVES	EA	6	$725.00	$4,350	$500.00	$3,000		$1,225.00	$7,350
32	1/2" LINED STEEL FEED PIPING	LF	1,000	$20.00	$20,000	$5.00	$5,000		$25.00	$25,000
33	2" PVC CONDUIT FOR FEED PIPING	LF	1,000	$2.00	$2,000	$1.00	$1,000		$3.00	$3,000
34										
35	**TEMPORARY CHEMICAL SYSTEM**									
36	SYSTEM SET-UP AND REMOVAL	LS	1	$0.00	$0	$77,000	$77,000		$77,000.00	$77,000
37	DAILY RENTAL FEE (ASSUMING 6 MO. CONSTRUCTION)	EA	180	$1,000.00	$180,000	$0	$0		$1,000.00	$180,000
38										
39										
40	SUB-TOTAL				$659,710		$411,140			$1,070,850
41	5% SALE TAX				$32,986					
42	50% LABOR BURDEN						$205,570			
43										
44	SUB-TOTAL				$692,696		$616,710			$1,309,406
45	5% SUB BOND & INS (50% OF PROJECT)									$32,735
46										
47	SUB-TOTAL									$1,342,141
48	10% SUB O/H (50% OF PROJECT)									$67,107
49										
50	SUB-TOTAL									$1,409,248
51	10% SUB PROFIT (50% OF PROJECT)									$70,462
52										
53	SUB-TOTAL									$1,479,710
54	5% PRIME BOND AND INS									$73,986
55										
56	SUB-TOTAL									$1,553,696
57	10% PRIME O/H									$155,370
58										
59	SUB-TOTAL									$1,709,065
60	10% PRIME PROFIT									$170,907
61										
62	SUB-TOTAL									$1,879,972
63	5% MOB / DEMOB									$93,999
64										
65	SUB-TOTAL									$1,973,970
66	25% CONTINGENCY									$493,493
67										
68	TOTAL									$2,467,463
69										
70	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$2,759,012

Project: Sodium Hypochlorite Study Sheet No. : ______ of ______
Location: McMillan WTP
Project No.
Description: Use slow sand filters for Caustic and Acid storage

Design Status:
[X] No Design Completed
[ ] Preliminary Design
[ ] Final Design
[ ] Other:

Remarks: **Figure 5.6**
Sulfuric Acid and Caustic Soda are used for final pH adjustment
Target storage of 24,000 gal Caustic and 5,000 gal S. Acid

Done By: ______ Date: ______
Chkd By: ______ Date: ______

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST	TOTAL UNIT COST	TOTAL COST
	SLOW SAND FILTER AREA CONVERSION								
1	DEMO EXISTING (REMOVE SAND, ETC.)	LS	1	$0.00	$0	$100,000.00	$100,000	$100,000.00	$100,000
2	CONCRETE CONTAINMENT CURB & SLABS	CY	250	$270.00	$67,500	$270.00	$67,500	$540.00	$135,000
3	EXCAVATION BACKFILL	CY	200	$25.00	$5,000	$25.00	$5,000	$50.00	$10,000
4	CONCRETE PIPE TRENCH	LF	850	$125.00	$106,250	$37.50	$31,875	$162.50	$138,125
5	CORE FILTER WALL	LS	2	$0.00	$0	$1,500.00	$3,000	$1,500.00	$3,000
6									
7	**CAUSTIC SODA**								
8	8' FRP HORIZONTAL CAUSTIC SODA TANKS - 3,000 GALLON	EA	8	$10,000.00	$80,000	$10,000.00	$80,000	$20,000.00	$160,000
9	LEVEL SENSORS	EA	8	$2,000.00	$16,000	$2,000.00	$16,000	$4,000.00	$32,000
10	8" PVC TANK VENTS	EA	8	$600.00	$4,800	$600.00	$4,800	$1,200.00	$9,600
11	3" PVC TANK DRAIN VALVES	EA	8	$260.00	$2,080	$260.00	$2,080	$520.00	$4,160
12	TANK HEATERS	EA	8	$1,200.00	$9,600	$1,200.00	$9,600	$2,400.00	$19,200
13	2" FILL LINES	LF	400	$22.00	$8,800	$22.00	$8,800	$44.00	$17,600
14	2" FILL VALVES	EA	2	$500.00	$1,000	$500.00	$1,000	$1,000.00	$2,000
15	FEED PUMPS	EA	3	$20,000.00	$60,000	$20,000.00	$60,000	$40,000.00	$120,000
16	FLOW METERS	EA	3	$8,500.00	$25,500	$8,500.00	$25,500	$17,000.00	$51,000
17	PUMP CONTROL	EA	3	$15,000.00	$45,000	$15,000.00	$45,000	$30,000.00	$90,000
18	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
19	3" LINED STEEL TANK PIPING	LF	1,000	$32.00	$32,000	$32.00	$32,000	$64.00	$64,000
20	3" LINED DUCTILE VALVES	EA	24	$725.00	$17,400	$725.00	$17,400	$1,450.00	$34,800
21	1" LINED STEEL FEED PIPING	LF	1,000	$25.00	$25,000	$25.00	$25,000	$50.00	$50,000
22									
23	**SULFURIC ACID**								
24	8' STEEL ACID TANKS - 3,000 GALLON	EA	2	$14,000.00	$28,000	$14,000.00	$28,000	$28,000.00	$56,000
25	LEVEL SENSORS	EA	2	$2,000.00	$4,000	$2,000.00	$4,000	$4,000.00	$8,000
26	8" PVC TANK VENTS	EA	2	$600.00	$1,200	$600.00	$1,200	$1,200.00	$2,400
27	3" PVC TANK DRAIN VALVES	EA	2	$260.00	$520	$260.00	$520	$520.00	$1,040
28	2" FILL LINES	LF	200	$22.00	$4,400	$22.00	$4,400	$44.00	$8,800
29	2" FILL VALVES	EA	2	$500.00	$1,000	$500.00	$1,000	$1,000.00	$2,000
30	FEED PUMPS	EA	2	$20,000.00	$40,000	$20,000.00	$40,000	$40,000.00	$80,000
31	FLOW METERS	EA	2	$8,500.00	$17,000	$8,500.00	$17,000	$17,000.00	$34,000
32	PUMP CONTROL	EA	2	$15,000.00	$30,000	$15,000.00	$30,000	$30,000.00	$60,000
33	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
34	3" LINED STEEL TANK PIPING	LF	300	$32.00	$9,600	$32.00	$9,600	$64.00	$19,200
35	3" LINED DUCTILE VALVES	EA	6	$725.00	$4,350	$725.00	$4,350	$1,450.00	$8,700
36	1/2" LINED STEEL FEED PIPING	LF	1,000	$20.00	$20,000	$20.00	$20,000	$40.00	$40,000
37	2" PVC CONDUIT FOR FEED PIPING	LF	1,000	$2.00	$2,000	$2.00	$2,000	$4.00	$4,000
38									
39									
40	SUB-TOTAL				$672,500		$701,125		$1,373,625
41	5% SALE TAX				$33,625				
42	50% LABOR BURDEN						$350,563		
43									
44	SUB-TOTAL				$706,125		$1,051,688		$1,757,813
45	5% SUB BOND & INS (50% OF PROJECT)								$43,945
46									
47	SUB-TOTAL								$1,801,758
48	10% SUB O/H (50% OF PROJECT)								$90,088
49									
50	SUB-TOTAL								$1,891,846
51	10% SUB PROFIT (50% OF PROJECT)								$94,592
52									
53	SUB-TOTAL								$1,986,438
54	5% PRIME BOND AND INS								$99,322
55									
56	SUB-TOTAL								$2,085,760
57	10% PRIME O/H								$208,576
58									
59	SUB-TOTAL								$2,294,336
60	10% PRIME PROFIT								$229,434
61									
62	SUB-TOTAL								$2,523,769
63	5% MOB / DEMOB								$126,188
64									
65	SUB-TOTAL								$2,649,958
66	25% CONTINGENCY								$662,489
67									
68	TOTAL (FEB 2007)								$3,312,447
69									
70	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)								$3,703,837

Environmental Engineering and Technology, Inc.

Project: DALECARLIA SODIUM HYPOCHLORITE   Sheet No. : ______ of ______
Location: DALECARLIA WTP
Project No.
Description: Convert Exixting Chlorine Building into Caustic and S. Acid Building
During Construction of the new Hypochlorite Facility

Design Status:
- [x] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: Figure 5.7   Done By: ______ Date: ______

S. acid for coagulation pH adjustment.   Chkd By: ______ Date: ______
Caustic for final pH adjustment.

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST	TOTAL UNIT COST	TOTAL COST
	BUILDING CONVERSION								
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000	$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	38	$270.00	$10,260	$130.00	$4,940	$400.00	$15,200
3	CONCRETE CONTAINMENT CURB	CY	10	$270.00	$2,700	$130.00	$1,300	$400.00	$4,000
4	HVAC IMPROVEMENTS--EXISTING	SF	5,000	$2.00	$10,000	$2.00	$10,000	$4.00	$20,000
5	HAZARDOUS WORKING AREA TRAINING AND PRECAUTIONS	LS	1	$0.00	$0	$50,000.00	$50,000	$50,000.00	$50,000
6									
7	**CAUSTIC SODA**								
8	12' FRP CAUSTIC SODA TANKS - 11,800 GALLON	EA	4	$23,500.00	$94,000	$10,000.00	$40,000	$33,500.00	$134,000
9	LEVEL SENSORS	EA	4	$2,000.00	$8,000	$600.00	$2,400	$2,600.00	$10,400
10	8" PVC TANK VENTS	EA	4	$600.00	$2,400	$300.00	$1,200	$900.00	$3,600
11	3" PVC TANK DRAIN VALVES	EA	4	$260.00	$1,040	$100.00	$400	$360.00	$1,440
12	2" FILL LINES	LF	300	$22.00	$6,600	$8.00	$2,400	$30.00	$9,000
13	2" FILL VALVES	EA	2	$500.00	$1,000	$250.00	$500	$750.00	$1,500
14	FEED PUMPS	EA	3	$20,000.00	$60,000	$6,000.00	$18,000	$26,000.00	$78,000
15	FLOW METERS	EA	3	$8,500.00	$25,500	$3,000.00	$9,000	$11,500.00	$34,500
16	PUMP CONTROL	EA	3	$15,000.00	$45,000	$15,000.00	$45,000	$30,000.00	$90,000
17	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
18	3" LINED STEEL TANK PIPING	LF	840	$32.00	$26,880	$10.00	$8,400	$42.00	$35,280
19	3" LINED DUCTILE VALVES	EA	12	$725.00	$8,700	$500.00	$6,000	$1,225.00	$14,700
20	1" LINED STEEL FEED PIPING	LF	2,500	$25.00	$62,500	$5.00	$12,500	$30.00	$75,000
21	EXCAVATION BACKFILL	CY	450	$25.00	$11,250	$5.00	$2,250	$30.00	$13,500
22	CONCRETE PIPE TRENCH	LF	1,000	$125.00	$125,000	$50.00	$50,000	$175.00	$175,000
23									
24	**SULFURIC ACID**								
25	12' STEEL ACID TANKS - 11,800 GALLON	EA	2	$34,000.00	$68,000	$12,000.00	$24,000	$46,000.00	$92,000
26	LEVEL SENSORS	EA	2	$2,000.00	$4,000	$600.00	$1,200	$2,600.00	$5,200
27	8" PVC TANK VENTS	EA	2	$600.00	$1,200	$300.00	$600	$900.00	$1,800
28	3" PVC TANK DRAIN VALVES	EA	2	$260.00	$520	$100.00	$200	$360.00	$720
29	2" FILL LINES	LF	300	$22.00	$6,600	$8.00	$2,400	$30.00	$9,000
30	2" FILL VALVES	EA	2	$500.00	$1,000	$250.00	$500	$750.00	$1,500
31	FEED PUMPS	EA	2	$20,000.00	$40,000	$6,000.00	$12,000	$26,000.00	$52,000
32	FLOW METERS	EA	2	$8,500.00	$17,000	$3,000.00	$6,000	$11,500.00	$23,000
33	PUMP CONTROL	EA	2	$15,000.00	$30,000	$15,000.00	$30,000	$30,000.00	$60,000
34	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
35	3" LINED STEEL TANK PIPING	LF	300	$32.00	$9,600	$10.00	$3,000	$42.00	$12,600
36	3" LINED DUCTILE VALVES	EA	4	$725.00	$2,900	$500.00	$2,000	$1,225.00	$4,900
37	1/2" LINED STEEL FEED PIPING	LF	550	$20.00	$11,000	$5.00	$2,750	$25.00	$13,750
38	2" PVC CONDUIT FOR FEED PIPING	LF	500	$2.00	$1,000	$1.00	$500	$3.00	$1,500
39	EXCAVATION BACKFILL	CY	225	$25.00	$5,625	$5.00	$1,125	$30.00	$6,750
40	CONCRETE PIPE TRENCH	LF	500	$125.00	$62,500	$50.00	$25,000	$175.00	$87,500
41									
42									
43	SUB-TOTAL				$766,275		$480,065		$1,246,340
44	5% SALE TAX				$38,314				
45	50% LABOR BURDEN						$240,033		
46									
47	SUB-TOTAL				$804,589		$720,098		$1,524,686
48	5% SUB BOND & INS (50% OF PROJECT)								$38,117
49									
50	SUB-TOTAL								$1,562,803
51	10% SUB O/H (50% OF PROJECT)								$78,140
52									
53	SUB-TOTAL								$1,640,944
54	10% SUB PROFIT (50% OF PROJECT)								$82,047
55									
56	SUB-TOTAL								$1,722,991
57	5% PRIME BOND AND INS								$86,150
58									
59	SUB-TOTAL								$1,809,140
60	10% PRIME O/H								$180,914
61									
62	SUB-TOTAL								$1,990,054
63	10% PRIME PROFIT								$199,005
64									
65	SUB-TOTAL								$2,189,060
66	5% MOB / DEMOB								$109,453
67									
68	SUB-TOTAL								$2,298,513
69	25% CONTINGENCY								$574,628
70									
71	TOTAL (FEB 2007)								$2,873,141
72									
73	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)								$3,212,624

Project: DALECARLIA SODIUM HYPOCHLORITE — Sheet No. : ______ of ______
Location: DALECARLIA WTP
Project No.
Description: Convert Exixting Chlorine Building into Caustic and S. Acid Building
After Completion of the new hypochlorite facility

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: **Figure 5.7** — Done By: ______ Date: ______
S. acid for coagulation pH adjustment. — Chkd By: ______ Date: ______
Caustic for final pH adjustment.

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST	TOTAL UNIT COST	TOTAL COST
	BUILDING CONVERSION								
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000	$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	38	$270.00	$10,260	$130.00	$4,940	$400.00	$15,200
3	CONCRETE CONTAINMENT CURB	CY	10	$270.00	$2,700	$130.00	$1,300	$400.00	$4,000
4	HVAC IMPROVEMENTS--EXISTING	SF	5,000	$2.00	$10,000	$2.00	$10,000	$4.00	$20,000
5									
6	**CAUSTIC SODA**								
7	12' FRP CAUSTIC SODA TANKS - 11,800 GALLON	EA	4	$23,500.00	$94,000	$10,000.00	$40,000	$33,500.00	$134,000
8	LEVEL SENSORS	EA	4	$2,000.00	$8,000	$600.00	$2,400	$2,600.00	$10,400
9	8" PVC TANK VENTS	EA	4	$600.00	$2,400	$300.00	$1,200	$900.00	$3,600
10	3" PVC TANK DRAIN VALVES	EA	4	$260.00	$1,040	$100.00	$400	$360.00	$1,440
11	2" FILL LINES	LF	300	$22.00	$6,600	$8.00	$2,400	$30.00	$9,000
12	2" FILL VALVES	EA	2	$500.00	$1,000	$250.00	$500	$750.00	$1,500
13	FEED PUMPS	EA	3	$20,000.00	$60,000	$6,000.00	$18,000	$26,000.00	$78,000
14	FLOW METERS	EA	3	$8,500.00	$25,500	$3,000.00	$9,000	$11,500.00	$34,500
15	PUMP CONTROL	EA	3	$15,000.00	$45,000	$15,000.00	$45,000	$30,000.00	$90,000
16	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
17	3" LINED STEEL TANK PIPING	LF	840	$32.00	$26,880	$10.00	$8,400	$42.00	$35,280
18	3" LINED DUCTILE VALVES	EA	12	$725.00	$8,700	$500.00	$6,000	$1,225.00	$14,700
19	1" LINED STEEL FEED PIPING	LF	2,500	$25.00	$62,500	$5.00	$12,500	$30.00	$75,000
20	EXCAVATION BACKFILL	CY	450	$25.00	$11,250	$5.00	$2,250	$30.00	$13,500
21	CONCRETE PIPE TRENCH	LF	1,000	$125.00	$125,000	$50.00	$50,000	$175.00	$175,000
22	**SULFURIC ACID**								
23	12' STEEL ACID TANKS - 11,800 GALLON	EA	2	$34,000.00	$68,000	$12,000.00	$24,000	$46,000.00	$92,000
24	LEVEL SENSORS	EA	2	$2,000.00	$4,000	$600.00	$1,200	$2,600.00	$5,200
25	8" PVC TANK VENTS	EA	2	$600.00	$1,200	$300.00	$600	$900.00	$1,800
26	3" PVC TANK DRAIN VALVES	EA	2	$260.00	$520	$100.00	$200	$360.00	$720
27	2" FILL LINES	LF	300	$22.00	$6,600	$8.00	$2,400	$30.00	$9,000
28	2" FILL VALVES	EA	2	$500.00	$1,000	$250.00	$500	$750.00	$1,500
29	FEED PUMPS	EA	2	$20,000.00	$40,000	$0.00	$6,000	$20,000.00	$40,000
30	FLOW METERS	EA	2	$8,500.00	$17,000	$3,000.00	$6,000	$11,500.00	$23,000
31	PUMP CONTROL	EA	2	$15,000.00	$30,000	$15,000.00	$30,000	$30,000.00	$60,000
32	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
33	3" LINED STEEL TANK PIPING	LF	300	$32.00	$9,600	$10.00	$3,000	$42.00	$12,600
34	3" LINED DUCTILE VALVES	EA	4	$725.00	$2,900	$500.00	$2,000	$1,225.00	$4,900
35	1/2" LINED STEEL FEED PIPING	LF	550	$20.00	$11,000	$5.00	$2,750	$25.00	$13,750
36	2" PVC CONDUIT FOR FEED PIPING	LF	500	$2.00	$1,000	$1.00	$500	$3.00	$1,500
37	EXCAVATION BACKFILL	CY	225	$25.00	$5,625	$5.00	$1,125	$30.00	$6,750
38	CONCRETE PIPE TRENCH	LF	500	$125.00	$62,500	$50.00	$25,000	$175.00	$87,500
39									
40	**TEMPORARY CHEMICAL SYSTEM**								
41	SYSTEM SET-UP AND REMOVAL	LS	1	$0.00	$0	$55,000.00	$55,000	$55,000.00	$55,000
42	DAILY RENTAL FEE (ASSUMING 6 MO. CONSTRUCTION)	EA	180	$500.00	$90,000	$0	$0	$500.00	$90,000
43									
44									
45	SUB-TOTAL				$856,275		$479,065		$1,335,340
46	5% SALE TAX				$42,814				
47	50% LABOR BURDEN						$239,533		
48									
49	SUB-TOTAL				$899,089		$718,598		$1,617,686
50	5% SUB BOND & INS (50% OF PROJECT)								$40,442
51									
52	SUB-TOTAL								$1,658,128
53	10% SUB O/H (50% OF PROJECT)								$82,906
54									
55	SUB-TOTAL								$1,741,035
56	10% SUB PROFIT (50% OF PROJECT)								$87,052
57									
58	SUB-TOTAL								$1,828,087
59	5% PRIME BOND AND INS								$91,404
60									
61	SUB-TOTAL								$1,919,491
62	10% PRIME O/H								$191,949
63									
64	SUB-TOTAL								$2,111,440
65	10% PRIME PROFIT								$211,144
66									
67	SUB-TOTAL								$2,322,584
68	5% MOB / DEMOB								$116,129
69									
70	SUB-TOTAL								$2,438,713
71	25% CONTINGENCY								$609,678
72									
73	TOTAL (FEB 2007)								$3,048,391
74									
75	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)								$3,408,581

Appendix C. Optimal Corrosion Control Treatment Requirements for the Washington Aqueduct

0616-151648

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III
1650 Arch Street
Philadelphia, Pennsylvania 19103-2029

Thomas P. Jacobus
General Manager
Washington Aqueduct Division
U.S. Army Corps of Engineers
5900 MacArthur Boulevard, NW
Washington, DC 20016-2514

JUN 14 2006

John T. Dunn, P.E.
Chief Engineer/Deputy General Manager
District of Columbia Water and Sewer Authority
5000 Overlook Avenue, SW
Washington, DC 20032

RECEIVED
GENERAL MANAGER'S OFFICE
2006 JUN 16 P 2:41
WATER & SEWER AUTHORITY

Gentlemen:

The United States Environmental Protection Agency Region III ("EPA") has primacy for the Public Water System Supervision ("PWSS") Program in the District of Columbia. The primacy agency is responsible for implementing the PWSS Program and the National Primary Drinking Water Regulations ("NPDWRs"), including designation of optimal corrosion control treatment ("OCCT") under the Lead and Copper Rule ("LCR") for public water systems. By this letter, EPA is designating a final OCCT for the drinking water treatment and distribution system for the District of Columbia. EPA previously set interim water quality parameters ("WQP") and requirements for monitoring and reporting in its August 3, 2004 letter, subsequently modified the interim WQPs in an August 20, 2004 letter, and summarized interim WQPs for clarity in a September 8, 2004 letter.

EPA is now directing the Washington Aqueduct and the District of Columbia Water and Sewer Authority ("DC WASA") to perform monitoring to determine compliance with the WQPs set forth by this final OCCT designation. The Washington Aqueduct and DC WASA shall continue full monitoring for lead and copper (per 40 CFR §141.86) as well as perform monitoring for the WQPs as described herein and pursuant to 40 CFR §141.87. For purposes of this final OCCT designation, the six-month period referenced in 40 CFR §141.87(d) commenced January 2006.

The final OCCT designation described herein is based on data reported to EPA since the initiation of orthophosphate treatment on August 23, 2004. In its August 3, 2004 letter, EPA stated that the OCCT designation was considered an "interim" designation because it applied only to the passivation period. DC WASA and the Washington Aqueduct have submitted monthly reports of interim WQP data, and DC WASA has submitted data from routine lead and copper monitoring conducted pursuant to 40 CFR §141.86. On May 3, 2006, DC WASA certified achievement of a second consecutive six-month monitoring period under the LCR at or below the lead action level.

DC WASA has been performing interim WQP monitoring at total coliform rule (TCR) sampling sites and at twenty-five (25) supplemental sites, representative of dead-end and low flow areas of the distribution system, as required by EPA's interim designation. The Washington Aqueduct has been monitoring for interim WQPs in finished water leaving the Dalecarlia and McMillan treatment plants.

Per this final OCCT designation, EPA directs the Washington Aqueduct to continue monitoring for applicable final WQPs in finished water leaving the Dalecarlia and McMillan treatment plants per 40 CFR §141.87(c). The Washington Aqueduct is directed to submit to EPA the sampling schedule that will be used for WQP monitoring within two weeks of the date of this letter.

EPA also directs DC WASA to monitor for applicable WQPs in tap samples at twenty-five (25) predetermined locations in the distribution system no less than twice during each six-month monitoring period, per 40 CFR §141.87(c). EPA strongly encourages DC WASA to conduct WQP monitoring at tap sampling locations selected from TCR sampling sites and from the former supplemental sites that have yielded valuable information on the condition of the distribution system. DC WASA is directed to submit to EPA for review and comment a WQP monitoring plan consisting of a list of the distribution system sampling sites and the sampling schedule that will be used for WQP monitoring within two weeks of the date of this letter. Only samples taken pursuant to this WQP monitoring plan will be considered for purposes of determining compliance with 40 CFR §141.82 and §141.87. EPA requests notification in the event that DC WASA must change any of the distribution system WQP sites during a monitoring period. EPA may consider a request by DC WASA to allow reduced monitoring for WQPs after reviewing the data from the January – June 2006 and July – December 2006 monitoring periods.

As part of the interim OCCT designation, the initial dose of orthophosphate was set at the high end of normal operation in order to passivate the distribution system. As the interim designation was intended to cover the period of passivation, the final OCCT designation will apply as the orthophosphate dose is decreased to and achieves a final maintenance dose. EPA has learned that as of January 30, 2006, after consultation with its customers, the Washington Aqueduct decreased the orthophosphate dose to a level that will provide a 2 mg/L residual in the distribution system. EPA understands that the dose of orthophosphate will slowly be decreased to a final maintenance dose of approximately 0.5 – 1.5 mg/L, as measured in tap samples. The Technical Expert Working Group ("TEWG"), established in February 2004, has discussed this process and has identified decreasing the orthophosphate concentration to a lower maintenance dose as a common industry practice. Pipe loop experiments have not identified adverse effects of decreasing orthophosphate concentrations. Lead tap sampling data over the next year will be valuable in assessing the effects, if any, of this operational modification on lead levels in the distribution system. EPA highly recommends that DC WASA continue performing monthly home lead profile analyses throughout the orthophosphate reduction period and periodically thereafter.

We understand that the Washington Aqueduct plans to install caustic soda (sodium hydroxide) facilities for finer control of finished water pH ("pH trimming") at both treatment plants. EPA expects that the Washington Aqueduct will comply with the final pH WQP once caustic soda feed is operational at both treatment plants. Until that time, the interim pH WQP applies to the Aqueduct.

Please see the enclosure for a summary of the WQP monitoring and reporting requirements for the Washington Aqueduct and DC WASA associated with the final OCCT designation. The supplemental monitoring, required by the interim OCCT designation and performed according to DC WASA's November 8, 2004 supplemental monitoring plan, is not required as part of the final OCCT. Pursuant to 40 CFR §141.82(h), EPA may modify its OCCT determination in the future to ensure that the system continues to implement optimized corrosion control treatment.

EPA commends DC WASA and the Washington Aqueduct on their commitment to continue their rigorous water quality monitoring programs. Thank you for your continued efforts and dedication to continuous improvement of drinking water quality in the District of Columbia. If you or your staff require additional information, please contact Richard Rogers, Water Protection Division, EPA Region III at (215) 814-5711.

Sincerely,

Jon M. Capacasa, Director
Water Protection Division
EPA Region III

Enclosure

cc: Hugh Eggborn, Office of Water Programs, Culpepper Field Office, Virginia Department of Health
Robert Etris, Director of Public Utilities, City of Falls Church, Virginia
Randolph Bartlett, Arlington County Department of Public Works
William Brown, Ronald Reagan National Airport
Gregg Pane, District of Columbia Department of Health
Thomas Lewis, Naval District Washington
Charles Rimbach, Bolling Air Force Base

ENCLOSURE

Water Quality Parameter Monitoring and Reporting for Optimal Corrosion Control Treatment Designated June 14, 2006

Washington Aqueduct

Water quality parameters (WQPs) for water entering the distribution system:

	WQP	
pH	7.7 ± 0.1	(interim: $7.7 \pm 0.3^{‡}$)
Orthophosphate	$0.5 - 5.0$ mg/L*	

‡ EPA expects that the Washington Aqueduct will comply with the final pH WQP once caustic soda feed is operational at both treatment plants. Until that time, the interim pH WQP applies to the Aqueduct.

* Dose necessary to reach this residual (as dissolved orthophosphate) in tap samples. Any deviations from this range will be evaluated on a case-by-case basis. Reports shall indicate whether the applied dose is measured as total or dissolved orthophosphate.

Monitoring shall be conducted according to the frequency and other requirements in 40 CFR §141.87. The Washington Aqueduct is directed to submit to EPA the sampling schedule that will be used for WQP monitoring within two weeks of the date of this letter. Compliance shall be assessed pursuant to 40 CFR §141.82(g).

WQP excursions shall be reported to EPA no later than 10 days after the end of the month in which the excursion occurs. WQP reports shall be submitted to EPA within ten (10) days of the end of each six-month monitoring period.

DC WASA

Water quality parameters (WQPs) for locations in the distribution system selected pursuant to 40 CFR §141.87:

	WQP
pH	≥7.2
Orthophosphate residual	0.5 – 5.0 mg/L
Free ammonia nitrogen	Monitor & report
Nitrite nitrogen	Monitor & report

Orthophosphate shall be measured as dissolved orthophosphate. Any deviations from the orthophosphate WQP range will be evaluated on a case-by-case basis.

Monitoring shall be conducted at no less than 25 sampling locations and at a frequency of no less than two times every six month period, according to the requirements in 40 CFR §141.87.

DC WASA shall submit within two weeks of the date of this letter to EPA for review and comment a WQP monitoring plan consisting of a list of the distribution system sampling sites and the sampling schedule that will be used for WQP monitoring. Only samples taken pursuant to this WQP monitoring plan will be considered for purposes of determining compliance with 40 CFR §141.82 and §141.87. DC WASA shall notify EPA in the event that DC WASA must change any of the distribution system WQP sites during a monitoring period.

Compliance shall be assessed pursuant to 40 CFR §141.82(g).

WQP excursions shall be reported to EPA no later than 10 days after the end of the month in which the excursion occurs. WQP reports shall be submitted to EPA within ten (10) days of the end of each six-month monitoring period.

Appendix D. Lists of Site Visits and Vendor Presentations

Site Visits by Washington Aqueduct Staff

Richmond WTP (Bulk 12% aqueous sodium hypochlorite, in construction, and caustic soda)
Richmond, Virginia
September 28, 2006

Blue Plains AWWTP (Bulk 12% aqueous sodium hypochlorite and caustic soda)
Washington, DC
October 17, 2006

Ralph Brennan WTP (On-site aqueous sodium hypochlorite generation since 2001)
Daytona Beach, Florida
November 9, 2006

Corbalis WTP (Bulk 6% aqueous sodium hypochlorite, in construction)
Herndon, Virginia
November 30, 2006

Griffith WTP (Bulk 12% aqueous sodium hypochlorite)
Lorton, Virginia
December 5, 2006

Vendor Presentations to Washington Aqueduct Staff

MIOX (On-site sodium hypochlorite equipment)
September 12, 2007

Kuehne Chemical Co. (Bulk aqueous sodium hypochlorite)
September 14, 2006

Severn Trent (On-site sodium hypochlorite equipment)
October 5, 2006

Appendix E. Biological Factors Memorandum

CHRISTOPHER NEWPORT UNIVERSITY

Date: March 5 , 2007

To: EE&T, Inc.

From: James R. Reed, Jr. Ph.D.

Subject: Biological Factors
Corps of Engineers – WA
COE Task HOCl
EE&T Project No.3608

The purpose of this memorandum is to document if significant impacts may be expected on biological resources from implementation of the Proposed Action, conversion from chlorine gas to sodium hypochlorite for disinfection at the McMillan and Dalecarlia Water Treatment Plants. Evaluation included impacts on vegetation, wildlife, fish, and biological aspects of recreational resources. In addition, the potential for significant impacts to threatened or endangered species, wetlands, and any critical habitats were evaluated. Under the No-Action alternative, the installation of facilities for conversion from chlorine gas to sodium hypochlorite for disinfection at both plants would not occur and existing conditions would remain. No significant impacts on biological resources would occur under the No-Action alternative. The following observations and conclusions were made based upon a site visit within the McMillan and Dalecarlia Water Treatment Plant facilities conducted by me on March 8, 2007 and from information contained in the latest environmental documentation, Final Environmental Baseline Report for the Dalecarlia, Georgetown, and McMillan Reservoirs (USCOE. May, 1994) and the Final Environmental Assessment – Ammonia Storage, Feed, and Monitoring Facilities Dalecarlia and McMillan Water Treatment Plants, Washington, D.C. (USCOE, August 1997).

McMillan WTP

The conversion to sodium hypochlorite at McMillan requires either the addition of liquid storage tanks and pumps or the addition of sodium hypochlorite generation facilities. In both cases caustic soda tanks and pumps, and a sulfuric acid tank and pump need to be added. Existing chlorine gas feed equipment needs to be removed. The installation of liquid storage tanks or generation equipment will all take place within an existing building. Staging activities will be controlled by sediment and erosion control plans stipulated in the construction documents. The caustic soda and sulfuric acid tanks and pumps will also be within an existing structure. Some minor pipe trenching will be required with already disturbed WTP property. All tanks will be within containment structure to prevent spills or tank leakage from entering the environment. The location of the possible building is shown in Site Plan M-3 from EE&T, Inc. March 2007. ("Feasibility Study: Sodium Hypochlorite and Caustic Soda Facilities," prepared for U.S. Army Corps of Engineers, WAD.)

1 University Place Newport News, Virginia 23606-2998
Voice (757) 594-7000 TDD (757) 594-7938 FAX (757) 594-7713

These locations were examined, as well as the entire McMillan WTP site. Baseline conditions for terrestrial biological resources were similar to those described in the Final EA (FEA), USCOE, 1997. The land is landscaped and maintained. No continuous under story exists, but landscaping tree species are present. Herbaceous vegetation consists primarily of grasses. Because of the developed nature surrounding the site and the lack of contiguous wooded area, wildlife species in the vicinity are typical of those found in most urban areas (EBR, 1994 and FEA, 1997). Several common birds adapted to urban/suburban environments as well as species associated with bodies of water, were observed on the McMillan property during the site visit. These included European starlings, Canada geese, and several species of gulls (Photos M-1, M-2, and M-3). Several shorebirds (unidentified, but possibly killdeers, *Charadrius vociferous*) were also observed on the Number 6 filter (Photos M-3 and M-4) No other wildlife was observed.

The potential pipeline at the McMillan site will be a protected open trench from the Chemical Building (M-26) to an area east of Building M-17 and southward on the east side of Building M-27, terminating between Buildings M-5 and M-6 (Site Plan M-3, Photos M-5 and M-6). No significant biological resources exist along this route. The area is landscaped and maintained, but could be used by transient birds and animals occasionally for resting or feeding. Open vegetated land on the site is predominantly of this type and therefore it does not constitute a unique habitat type. Several landscape conifers are adjacent to Building M-27 and would probably be lost during pipeline construction. These trees are not unique and provide no significant wildlife habitat value. There will be no significant impacts on vegetation or terrestrial resources. There are no fish or recreational resources in the project area. There are also no wetlands or threatened or endangered species in the project area (EBR, 1994; FEA, 1997). As a result there will be no significant impact on these biological resources.

An alternative that would include a new building on the McMillan site south of Building M- 27 would have no significant impact on biological resources, as there are none there. The potential building site is near the proposed pipeline (Site Plan M-3). The land is mostly dirt with little grass or other vegetation at the present time (Photo M-7).

As noted in the pipeline evaluation above, transient birds or terrestrial animals could occasionally occur at the site, but there is nothing unique about it from a wildlife habitat perspective. No fish or threatened or endangered species exist there and there are no recreational resources present. In both project scenarios short-term impacts on transient wildlife would be due to construction noise and activity. Birds and other animals that might be in the area would likely move to undisturbed areas. Long-term impacts would be related to increased vehicle traffic and maintenance needed to serve the new facilities. These impacts would be minimal. A project office trailer would be sited so as to minimize any potential short-term impacts on biological resources that might enter the area.

Dalecarlia WTP

Dalecarlia construction will include the addition of a new building of approximate size 120 ft x 75 ft to house either new liquid storage tanks or hypochlorite generation equipment. A site plan showing the new building is attached Site Plan D-4 from EE&T March 2007 and Photo D-1. The area where the building will go is all within the WTP grounds and the existing area is either paved or maintained grass (Photos D-2 through D-6). The new caustic soda tanks will be installed in an existing building. Some minor pipe trenching for both hypochlorite and caustic soda will be required. There will be earthwork associated with the new building construction and pipe trenching. Disturbances will be controlled during construction by erosion and sediment control plans in the construction specification. All tanks will be within containment structures to prevent spills and leaks from entering the environment.

The project location, as well as the entire Dalecarlia WTP site was examined. As in the case of McMillan, baseline wildlife habitat conditions for terrestrial biological resources were similar to those described in the FEA, 1997 and EBR, 1994. No birds or other animals were observed in the project area. The building site is largely a paved parking lot with a small areas of the clearwell vegetated site included (Site Plan D-4). Open fields kept in landscaped grass overlie the clearwell area. A single ornamental tree exists adjacent to the chlorine storage building (Photos D-7 and D-8). It provides no unique habitat for wildlife since other mature, native trees of several species exist on the property. This tree will likely be lost due to building construction. A pipeline will be constructed from the new facility south to the chemical building with a branch running eastward to near the pumping station. It will be located within the existing parking lot and along the edge of the clearwell (Site Plan D-4, Photos D-9 through D-12).

As described above for the building site, there are no significant biological resources along the pipeline route. It will be in a protected, open trench with no opportunity for transient birds or other animals to be impacted. There are no fish or recreational resources in the project area. There are also no wetlands or threatened or endangered species present (EBR, 1994, FEA, 1997). A construction office trailer for the project will be located so as to minimize any impact on biological resources that might enter the area (Photo D-13). Any short-term impacts on transient birds or terrestrial animals will be related to construction activity and noise. It is likely that such activity would be no more disturbing than the maintenance activity observed at the project location during the site visit (Photos D-2 through D-7). It is likely that birds and other animals that might be in the area would move to undisturbed areas. Earthwork disturbance associated with new building construction and pipe trenching will be controlled by erosion and sediment control plans in the construction specification. Long-term impacts will be related to noise and disturbance associated with a slight increase in vehicle traffic supplying the new facility.

In summary, based upon the site visit conducted March 9, 2007, and the USCOE 1994 and 1997 documentation, there will be no significant impacts on biological resources related to the proposed projects at the McMillan or Dalecarlia Water Treatment plants.

There is a potential positive impact on wildlife from eliminating the risk associated to them from the potential for releases of gaseous chlorine if gaseous chlorine was no longer used.

PHOTOS

Photo M-1. Canadian geese at McMillan WTP

Photo M-2. Gull at McMillan WTP

Photo M-3. Common birds at McMillan WTP

Photo M-4. Shorebird observed at McMillan WTP (possibly C. Vociferous)

Photo M-5. Route of potential protected trench at McMillan WTP

Photo M-6. Vegetation on top of clearwell, near proposed protected trench

Photo M-7. McMillan WTP, site of proposed building

Photo D-1. Arial photo showing proposed site and structure of building at Dalecarlia WTP

Photos D-2 through D-6. Paved area near chlorine building; site of proposed building at Dalecarlia WTP

Photo D-2

Photo D-3

Photo D-4

Photo D-5

Photo D-6

Photo D-7. Ornamental tree near chlorine building (winter)

Photo D-8. Ornamental tree at chlorine building (Spring)

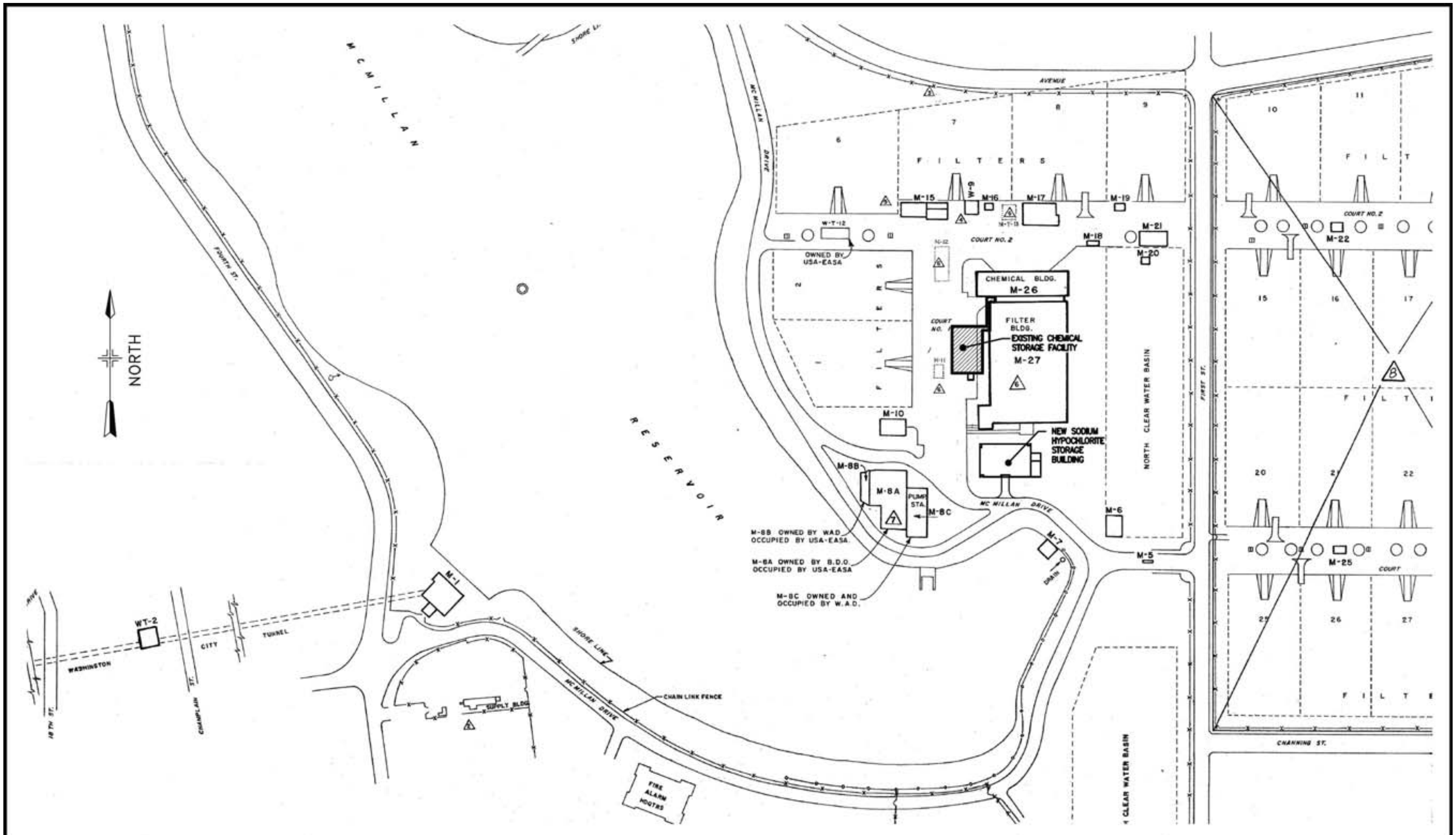
Photo D-9. Area of potential protected trench at Dalecarlia WTP

Photo D-10. Protected trench area at Dalecarlia WTP

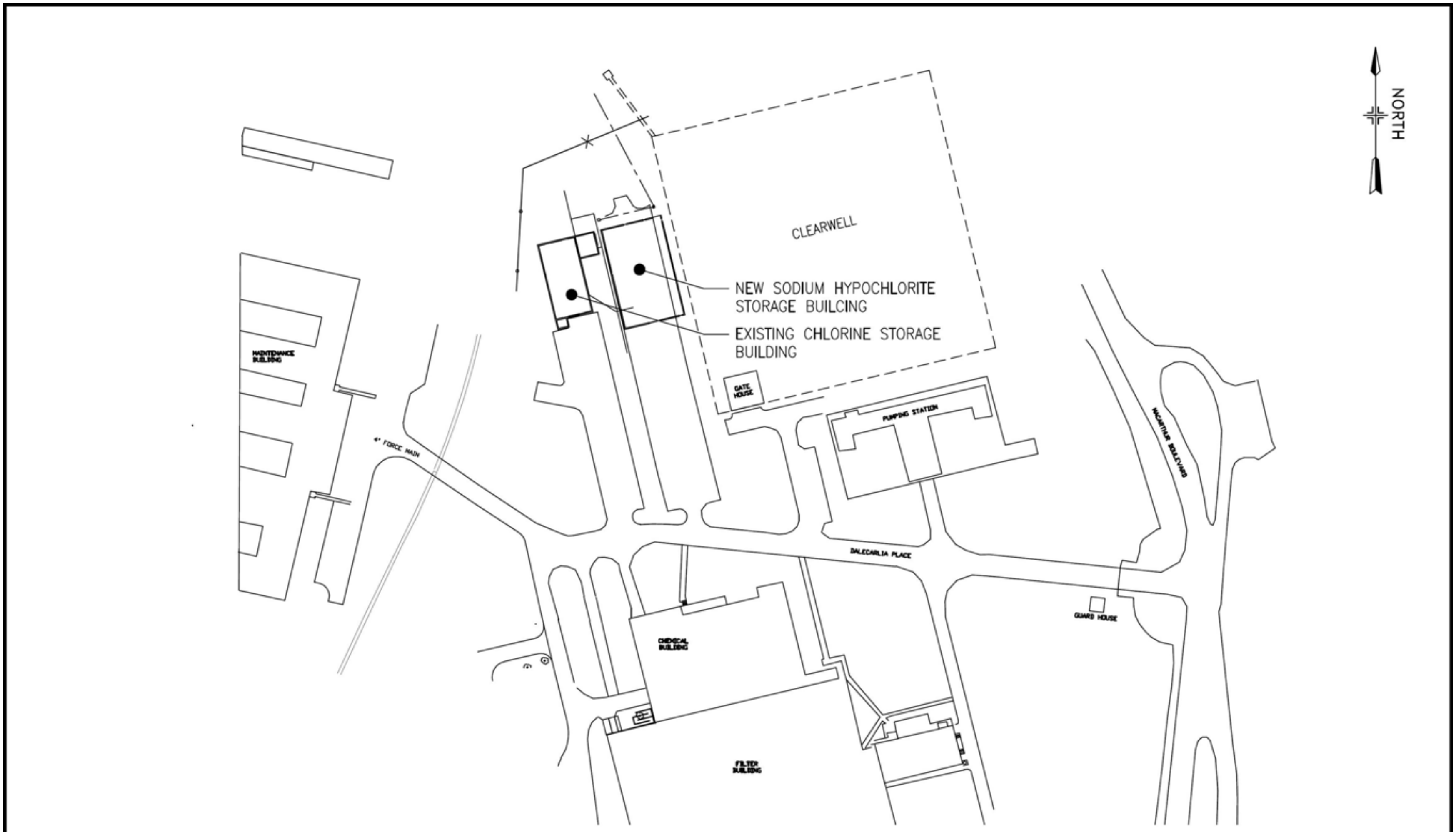
Photo D-11. Protected trench area at Dalecarlia WTP

Photo D-12. Protected trench area at Dalecarlia WTP

Photo D-13. Potential site of construction trailer at Dalecarlia WTP



EE&T, Inc. ENVIRONMENTAL ENGINEERING & TECHNOLOGY, INC. 712 gum rock court - newport news, virginia 23606 (757) 873-1534	McMillan Water Treatment Plant Storage for 6% Sodium Hypochlorite	JEA	DRAWING M2-SP
	Sodium Hypochlorite Facility Layout (New Building–Trucked in Tanks)	05.24.06	SCALE: NOT TO SCALE



EE&T, Inc. ENVIRONMENTAL ENGINEERING & TECHNOLOGY, INC. 712 gum rock court - newport news, virginia 23606 (757) 873-1534	Dalecarlia Water Treatment Plant Storage for 12% Sodium Hypochlorite	JEA	DRAWING D2–SP
	Sodium Hypochlorite Facility Layout (New Building – Trucked in Tanks)	06.20.06	SCALE: NOT TO SCALE

Appendix F. Transportation Analysis Memorandum

O. R. GEORGE & ASSOCIATES, INC.
Traffic Engineers – Transportation Planners

10210 Greenbelt Road, Suite 310 • Lanham, MD 20706-2218
Tel: (301) 794-7700 • Fax: (301) 794-4400
E-mail: ogeorge@orgengineering.com

March 28, 2007

Dr. David A. Cornwell, Principal
Environmental Engineering & Technology, Inc.
712 Gum Rock Court
Newport News, VA 23606

Re: Truck Traffic Impact Assessment - Regarding Chemical Processing
McMillan Reservoir Water Filtration Plant, Northwest, Washington, DC

Dear Dr. Cornwell:

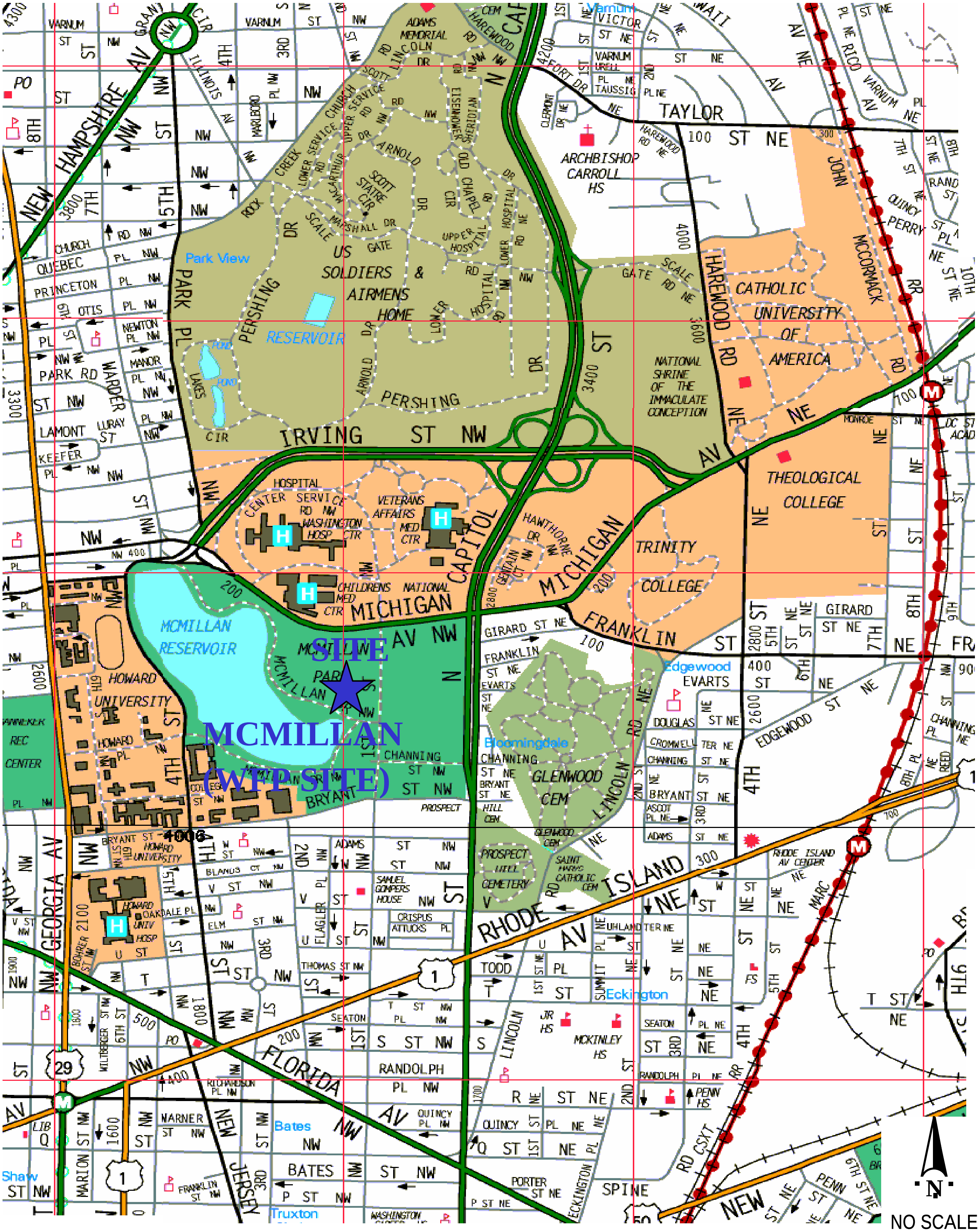
In accordance with your request, we have examined the traffic-related impacts associated with the proposal by the United States Corps of Engineers (The COE) to modify the chemical treatment process for the McMillan Water Filtration Plant, which is situated in the Howard University/Bloomingdale area of Northwest, Washington DC. More specifically, we note that the COE plans to increase the volume of chemicals hauled by trucks to the plant in order to modify the mix of chemicals involved in the treatment and filtration processes. This will constitute the Proposed Action. Under the Proposed Action, the program would increase the number of trucks accessing the plant under the following two (2) scenarios:

Projected Monthly Truck Activity (Truck Trips)

McMillan WFP Process Changes	Present Conditions	Future Conditions	Net Changes
1) On-Site Generation Option			
a) Average Monthly	7 Trucks	9 Trucks	(+2 Trucks)
b) Maximum Monthly	8 Trucks	10 Trucks	(+2 Trucks)
2) All-Delivery Option			
a) Average Monthly	7 Trucks	24 Trucks	(+17 Trucks)
b) Maximum Monthly	8 Trucks	29 Trucks	(+21 Trucks)

Source: EE&T Engineers, Inc., and O. R. George & Associates, Inc.

While this memorandum does not address the chemical aspects of the planned changes, it is relevant to note that the variations in projected truck/haulage activity are based upon the expected variances in the quality of water to be treated. It is also important to note that the McMillan Water Filtration Plant has considerable storage capacity, which will allow for significant flexibility in the "spread" of haulage activity over the days of the month, as well as the time of day for such deliveries. Further descriptions of the existing and alternative scenarios are included in Attachment 1. The remainder of this memorandum presents our assessment of the likely impact of the alternative program scenarios on the local environment of the McMillan Filtration Plant. For ease of reference, the location of the plant is shown in Exhibit 1 (on page 2).



O. R. GEORGE & ASSOCIATES, INC.	EXHIBIT 1
Traffic Engineers - Transportation Planners	Site Location Map – McMillan Water Filtration Plant Northwest, Washington, D.C.

Local Area Site Access Situation – (McMillan Reservoir FTP)

As noted, the McMillan WFP is situated west of First Street, N.W., in the Howard University/Bloomingdale area of Washington, DC. First Street is designated as a Collector roadway on the City's Functional Classification Map. Exhibit 2 is presented to show the functional classification of other principal area roadways that would likely be used by trucks that are attracted to the area. In order to get some sense of traffic operations within the local area, we reviewed several traffic studies conducted for major land uses. These included the following:

1) Traffic Impact Analysis – Children's National Medical Center, Planned Unit Development Application Northwest, Washington, D.C. by O. R. George & Associates, Inc. (August 2, 2006).
2) MedStar Health/Washington Hospital Center Rezoning Application – Transportation Impact Analysis by O. R. George & Associates, Inc (May 11, 2000).

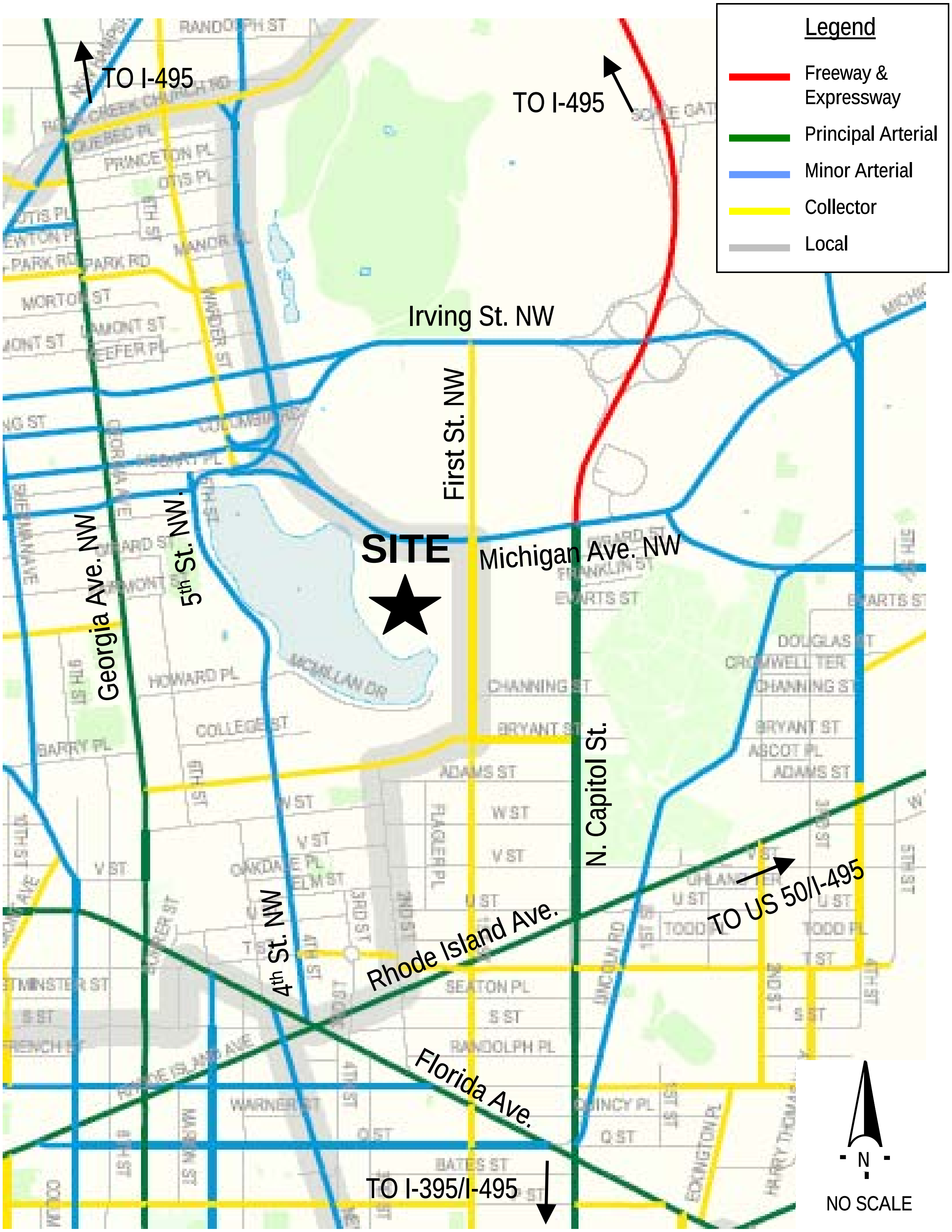
We also reviewed the Draft Environmental Impact Study which was prepared for the Federal Department of Veterans' Affairs in support of alternative development programs, for the Armed Forces Retirement Home. This campus development is situated along North Capitol Street, just to the north of WFP site. These studies all indicate that the major roadways such as North Capitol Street, Irving Street and Michigan Avenue serve reasonably high volumes of traffic, particularly during the morning and afternoon peak commuting periods. However, the most current study (for the Children's National Medical Center) shows that the local area intersections, nearest to the McMillan Filtration Plant, all operate at acceptable levels of service during both the morning and afternoon peak hours. The studies were all reviewed and accepted by the District of Columbia Department of Transportation Policy and Planning Administration[1]

Summary of Capacity Analysis Results - Existing Traffic Situation Study
Treatment McMillan Reservoir Water Filtration Plant

Intersection	AM Peak Hour		PM Peak Hour	
	Level of Service	Avg. Delay (Sec/Veh)*	Level of Service	Avg. Delay (Sec/Veh)*
1) Michigan Ave. at First St., NW	D	35.0	C	34.7
2) Michigan Ave. at CNMC Parking Garage Entry	B	13.8	A	8.8
3) Michigan Ave. at CNMC Parking Garage Exit	B	10.3	B	19.0
4) N. Capitol St. at Michigan Ave.	D	41.9	D	39.8

*Sec/Veh = Seconds per Vehicle
** Average delay per intersection
Source: O. R. George & Associates.

1 *"Level of Service" is a qualitative measure describing operational conditions within a traffic stream or at an intersection, and reflects their perception by drivers and other roadway users. Principal considerations are factors such as speed and travel time, delay, and freedom of maneuver, traffic interruptions, comfort, convenience and safety. Current engineering practice defines six (6) Levels of Service (A-F), with "A" representing best operating conditions, and Level of Service "F" representing the worst conditions. Level-of-Service D is generally considered by the District of Columbia as the minimum acceptable conditions for planning and design purposes.*



O. R. GEORGE & ASSOCIATES, INC. *Traffic Engineers - Transportation Planners*	**EXHIBIT 2** Aerial Road Classification – McMillan Water Filtration Plant, Northwest, Washington, D.C.

<u>Truck Access Considerations</u>

The traffic studies cited on page 3 considered truck traffic as part of the analysis presented for intersections and roadway links within the local area. In addition, relevant data and general considerations regarding opportunities for trucks accessing the area of the McMillan Water Filtration Plant are also presented in the District of Columbia "Motor Carrier" Study[2]. Some of these are highlighted below:

i) Washington, D.C. does not have designated "truck routes". However, notably recognized (de facto) truck routes within the impact area of the McMillan Water Filtration Plant include North Capitol Street, Michigan Avenue, Irving Street and Georgia Avenue.

ii) There are no truck restriction signs posted for other arterial and major collector roadways in the vicinity of the McMillan Water Filtration Plant.

iii) There are no major Truck Trip Generators within the vicinity of the McMillan WFP. The motor carrier study notes that approximately 80% of truck trips access the City from the northeast, and southwest via the major Freeway systems connecting the Beltway (I-95/495) and the US 50 Corridors.

No truck composition data are identified for the roadways in the vicinity of the WFP. However, the combined percentage of all truck types using First Street in the vicinity of the WFP is in the range of 0.90%.

It is relevant to note that two (2) well established and historic residential neighborhoods are situated to the south of the subject site. These are the Le Droit Park, and the Bloomingdale Communities to the south. Documentation presented in the City's files on the development applications cited earlier in this section indicated that the City implemented traffic calming measures along First Street, NW, and along several of the intersecting cross streets south of the site to the Rhode Island Avenue corridor. These included primarily multi-way stop signs at intersections, which had as the primary purpose discouraging through traffic approaching the institutional (hospital) uses to the north. The studies also included extensive traffic data for Michigan Avenue. This included Automatic Traffic Recorder counts showing the hourly fluctuations of traffic along this roadway on typical weekdays. Plots of directional traffic flows for Michigan Avenue are presented in Attachment 3.

While trucks are not prohibited from using adjacent roadways such as North Capitol Street, Michigan Avenue and Irving Street, these are not known to be major truck routes. None of them are shown as such in the Motor Carrier Study cited earlier. The study does note that Georgia Avenue near the DC–Maryland State line does carry significant heavy vehicle traffic, with trucks of all kinds in combination representing approximately 17.0% of all vehicles. However, it is noted that the "Motor Carrier Study" does not cite any major Truck Trip Generators within the vicinity of the WFP. The trucks to be used will be tractor trailer type of trucks. Typically a passenger car equivalent (pce) of 2.0 – 3.0 would be applied to the estimated truck trips. Even so, the impact on the typical weekday would be quite insignificant.

---

[2] "District of Columbia Motor Carrier Management and Threat Assessment Study" District Department of Transportation, and US Department of Transportation Research and Special Project Administration (August 2004).

It is understood that the chemicals that will be hauled to the McMillan WFP under the Proposed Action will originate outside of the City. It is envisioned that potential routes into the Plant will include the following:

1) Via New Hampshire Avenue and North Capitol Street from I-95 and I-495 to the north;
2) Via North Dakota Avenue and Michigan Avenue from the US 50 and I-495 Corridors to the east; and
3) Via North Capitol Street and the I-395 Center Leg Freeway Systems from I-395/I-495/I-95 to the South and west.

All of these routes would use major arterial roadways to access the local area. Left-turns are prohibited at Michigan Avenue for northbound traffic along North Capitol Street. This could impact trucks approaching from the south. However, they would have the option of utilizing the North Capitol Street/Irving Street interchange, which would involve only a minor "detour". This is considered further in the Summary Assessment and Conclusion section which follows.

<u>Summary Assessment and Conclusion (Proposed Action)</u>

As noted earlier, the treatment alternatives under consideration will generate a net increase of two (2) trucks per month under the *"On-Site Generation Option."* A net increase of nineteen (19) truck trips per month will be generated under the *"All-Delivery Option."* Further details are provided on page 1, and in Attachment 1. The increased level of truck trips would be equivalent to an average of one (1) trip every ten (10) days under the on-site generation, and one (1) trip per day under the high-end "*All-Delivery Option*".

As was noted earlier, the WFP provides for considerable on-site materials storage, allowing flexibility for dispersal of truck trips over the typical twenty (20) weekdays per month. Furthermore, these trips can be scheduled to occur outside of the peak hours of commuter traffic (i.e., between 9:30 AM and 4:00 PM). It is also worthy of note that it is standard industry practice that truck operators seek opportunities to operate their equipment during off-peak hours in view of the reduced delays experienced, and the associated reduction in operating costs.

In conclusion, this assessment notes that the level of potential increase in truck traffic falls well within the typical daily and peak period fluctuations in traffic. Accordingly, both scenarios under consideration as part of the Proposed Action can be accommodated on the local area road network, and should have no significant adverse impact on the transportation–related elements of the local environment. This refers particularly to vehicular delays, noise and emissions. With a further "eye toward mitigation", the management of the McMillan Water Filtration Plant should consider the following measures:

1) Schedule deliveries of chemicals outside of the typical weekday peak hours, wherever practical.
2) Direct the vendors to use designated routes within the local area to specifically exclude First Street to the south of the site and the east-west streets which serve the adjacent residential neighborhoods.

3) Being located within a central area of the City, clearly additional developments will occur within the area. However, the impacts of these developments are primarily related to weekday peak hour traffic conditions. Even considering their cumulative impacts, the assessment made regarding impacts of the changes at the McMillan Water Filtration Plant would not change. In any case, it is also noted that the planning studies for these developments (such as the Washington Hospital Center and the Children's National Medical Center) all assume additional growth in the traffic from other sources.

We trust that this satisfies your current requirements. Thank you.

Sincerely,
O. R. GEORGE & ASSOCIATES, INC.

Osborne George (ISB)

Osborne R. George
President

ORG/wa

Attachments: As Noted

ATTACHMENT

1

SCOPE AND DEFINITION
WATER FILTRATION PLANT
“PROPOSED ACTION”

EE&T, Inc.

Consulting Engineers & Architects

Date: January 4, 2007

Osborne George
O.R. George & Associates, INC.
Engineering Memorandum No. 1
EE&T Project No. 3608

Subject: Chemical Deliveries

Purpose

The purpose of this memorandum is to provide the transportation engineer information regarding the expected increase in truck traffic associated with pH control chemicals (lime, caustic soda, and sulfuric acid) and disinfection chemicals (chlorine gas, sodium hypochlorite, salt) at the Dalecarlia and McMillan water treatment plants while still using alum as the coagulant. Below are the addresses of the two plants, average delivery estimates in Tables 1 and 2, and maximum delivery estimates in Tables 3 and 4.

1. Dalecarlia Water Treatment Plant
   5900 MacArthur Boulevard, NW
   Washington, DC 20016-2514

2. McMillan Filtration Plant
   2500 1st Street, NW
   Washington, DC 20001-1022
   (Entrance is located on the West side of 1st St. NW, between Channing St. NW and Michigan Ave. NW)

Table 1. Average monthly deliveries for pH control and disinfection chemicals ($C1_2$ gas, NaOCl)

	Present Conditions			**Recommended Alternatives**			
	Cl_2 Gas	Lime	**Total**	NaOCl	Lime, Caustic Soda, Sulfuric Acid	**Total**	**Increase Over Present Conditions**
Dalecarlia	7	7	**14**	37	8	**45**	**31**
McMillan	4	3	**7**	21	3	**24**	**17**

Table 2. Average monthly deliveries for pH control and disinfection chemicals (Cl_2 gas, NaCl)

	Present Conditions			**Recommended Alternatives**			
	Cl_2 Gas	Lime	**Total**	On-site	Lime, Caustic Soda, Sulfuric Acid	**Total**	**Increase over present conditions**
Dalecarlia	7	7	**14**	10	8	**18**	**4**
McMillan	4	3	**7**	6	3	**9**	**2**

Table 3. Maximum monthly deliveries for pH control and disinfection chemicals (C1$_2$ gas, NaOCl)

	Present Conditions			**Recommended Alternatives**			
	Cl_2 Gas	Lime	**Total**	NaOCl	Lime, Caustic Soda, Sulfuric Acid	**Total**	**Increase over present conditions**
Dalecarlia	9	7	**16**	50	8	**58**	**42**
McMillan	5	3	**8**	26	3	**29**	**21**

Table 4. Maximum monthly deliveries for pH control and disinfection chemicals (Cl_2 gas, NaCl)

	Present Conditions			**Recommended Alternatives**			
	Cl_2 Gas	Lime	**Total**	On-site	Lime, Caustic Soda, Sulfuric Acid	**Total**	**Increase over present conditions**
Dalecarlia	9	7	**16**	14	8	**22**	**6**
McMillan	5	3	**8**	7	3	**10**	**2**

Conclusion

The present conditions scenario for this analysis was calculated using the two plants' current operating schemes. This was compared to the number of truck deliveries projected for the recommended pH control alternatives, and using either delivered sodium hypochlorite in Tables 1 and 3 or on-site generation in Tables 2 and 4, as described in the feasibility study. Included are lime, caustic soda, salt, and sodium hypochlorite deliveries for Dalecarlia, and sulfuric acid, caustic soda, salt, and sodium hypochlorite deliveries for McMillan. The anticipated pH control chemical deliveries (lime, caustic soda, sulfuric acid) may come in a variety of combinations depending on the pH of the raw water and the time of year. The maximum delivery estimates for disinfection chemicals were based on the 90th percentile of historical chlorine usage. No peaking factor was applied to the pH adjusting chemical estimates because the storage provided for these chemicals significantly exceeds the average monthly demand.

Tables 1 through 4 show the predicted truckloads per month delivered in bulk tank trucks usually incorporating 5,000 gallon tanks. The truckload calculations were based upon the trucks carrying 24 ton-loads of product as indicated by the chemical manufacturers as a reasonable maximum load weight. The chlorine gas deliveries were calculated based on trucks carrying a maximum load of 13 one-ton cylinders.

ATTACHMENT

2

DISTRICT OF COLOMBIA
MOTOR CARRIER MANAGEMENT
AND THREAT ASSESSMENT STUDY
RELEVANT EXTRACTS

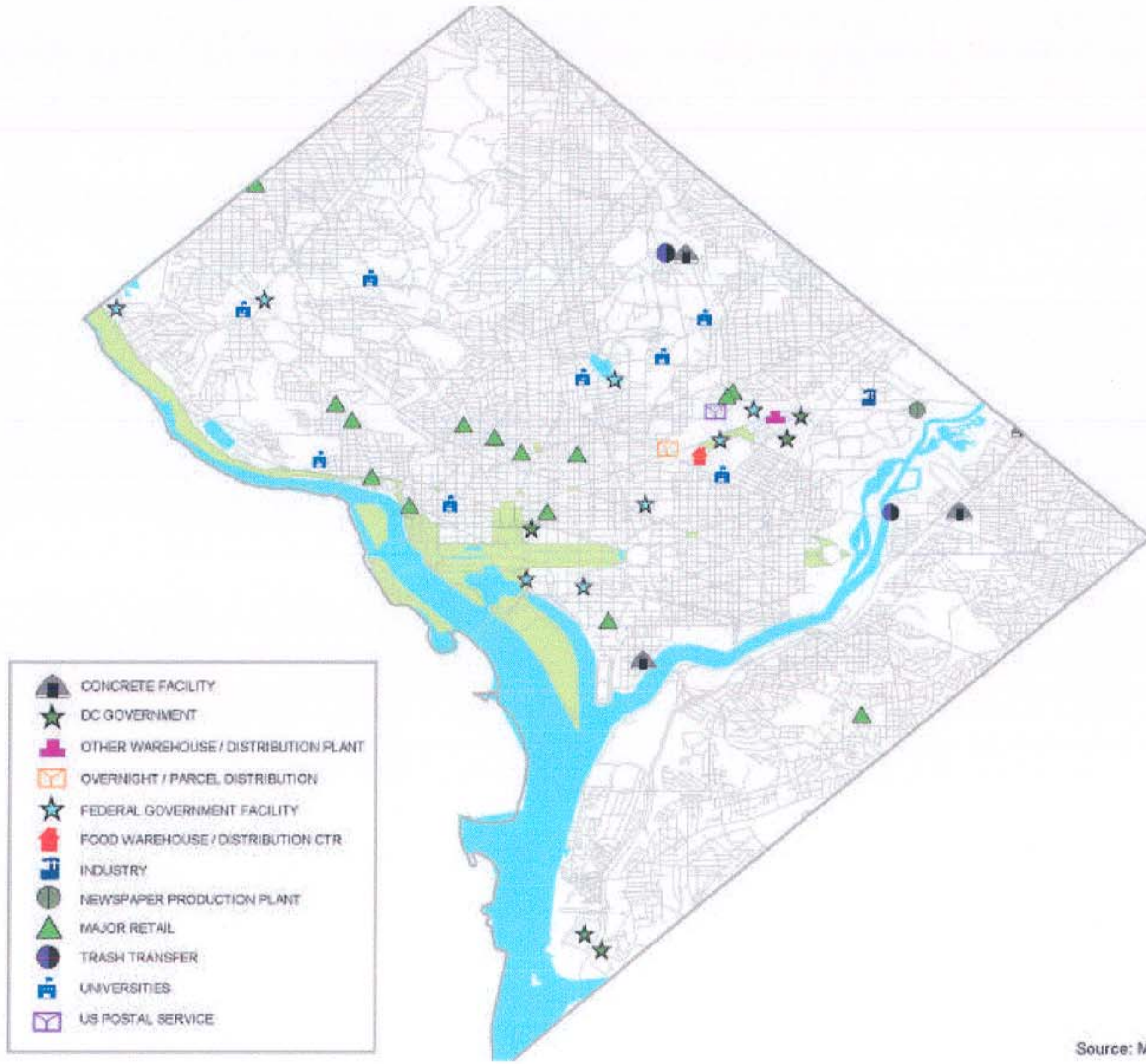
Final Report
August 2004

District of Columbia Motor Carrier Management and Threat Assessment Study

DISTRICT DEPARTMENT OF TRANSPORTATION

U.S. Department of Transportation
Research and Special Projects Administration
Volpe National Transportation Systems Center

Figure 3. Major Truck Trip Generators in the District



Source: MWCOG

DDOT provided manual counts for several locations in the District. For this study, Volpe picked count locations close to the District border in order to analyze inbound and outbound truck trips. Consultant DMJM Harris performed the manual counts for 8, 10, or 12 hours and then extrapolated 24-hour estimates from these counts. Table 2 shows the traffic composition in selected locations near the District borders based on these data. New York Avenue, Georgia Avenue, Kenilworth Avenue, and Suitland Parkway show the highest absolute volumes of truck traffic. Georgia Avenue and Piney Branch Road[2] have the greatest percentages of truck traffic among all the locations for which data are available: about 19 percent and 12 percent inbound and 15 percent and 12 percent outbound, respectively.

Table 2. Traffic Composition in Washington, DC: Inbound and Outbound

Location	Inbound			Outbound		
	Total Vehicles	Trucks	Percentage Trucks	Total Vehicles	Trucks	Percentage Trucks
16th St & Kalmia Rd NW	15,827	309	1.95%	14,602	396	2.71%
New York Ave & Bladensburg Rd NE	45,538	3,567	7.83%	45,007	3,485	7.74%
Georgia Ave NW (between Dahlia & Butternut St. NW)	12,060	2,235	18.53%	14,008	2,097	14.97%
Piney Brach Rd NW (between Blair Rd & Cedar St NW)	6,437	802	12.45%	6,800	801	11.78%
Connecticut & Nebraska Ave NW	18,863	859	4.55%	16,745	709	4.23%
Military & Glover Rd NW	15,877	518	3.26%	17,945	627	3.49%
Nebraska Ave & Albemarle St NW	12,715	182	1.43%	2,997	49	1.64%
Canal & Reservoir Rd NW	3,995	25	0.63%	4,798	55	1.15%
Canal Rd & Arizona Ave NW	24,647	778	3.16%	12,442	248	1.99%
Key Bridge & M St NW	23,700	482	2.03%	NA	NA	NA
Interstate 66	53,000	530	1.00%	47,000	470	1.00%
Interstate 395	107,000	270	0.25%	102,000	2,480	2.43%
Route 29 - Lee Highway	25,000	250	1.00%	NA	NA	NA
Pennsylvania & Branch Ave SE	18,748	1,072	5.72%	28,815	2,411	8.37%
Suitland Parkway & Stanton Rd SE	25,408	1,026	4.04%	26,600	1,419	5.33%

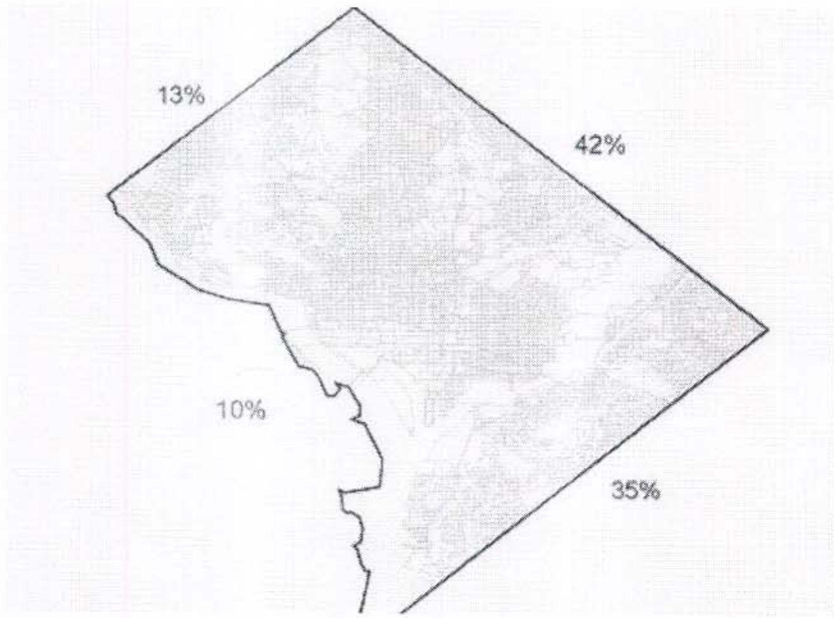
Figure 6 shows how inbound truck traffic is spread along the District border based on the percentage of total truck traffic entering the District from each of its four "sides."[3] More

[2] The high truck volumes on Piney Branch Road are probably a result of street reconstruction in the area and not a reflection of chronic high truck traffic on this roadway.

[3] In the absence of 24-hour counts on every major truck route (including Kenilworth and Rhode Island Avenues for which only AM and PM peak counts are available from MWCOG), the total number of trucks entering the District during any given period cannot be calculated. The data for Figures 6 and 7 were adjusted to account for incomplete cordon line counts. However, this introduces additional opportunity for error. The values in the figures should be taken as estimates of general trends rather than as exact percentages.

than 40 percent of trucks entering the District come in via the northeastern border with Maryland. This is expected since the Maryland suburbs to the east of the District and the eastern part of the District are home to many warehouses and transfer points, particularly along New York Avenue and in the Landover and Lanham, Maryland, areas. Additionally, truck traffic from Baltimore, New York City, and other locations on the Eastern Shore enters the District from the east. There is also substantial truck traffic from Maryland into southeast Washington.

Figure 6. Entrance Points for Inbound Truck Traffic



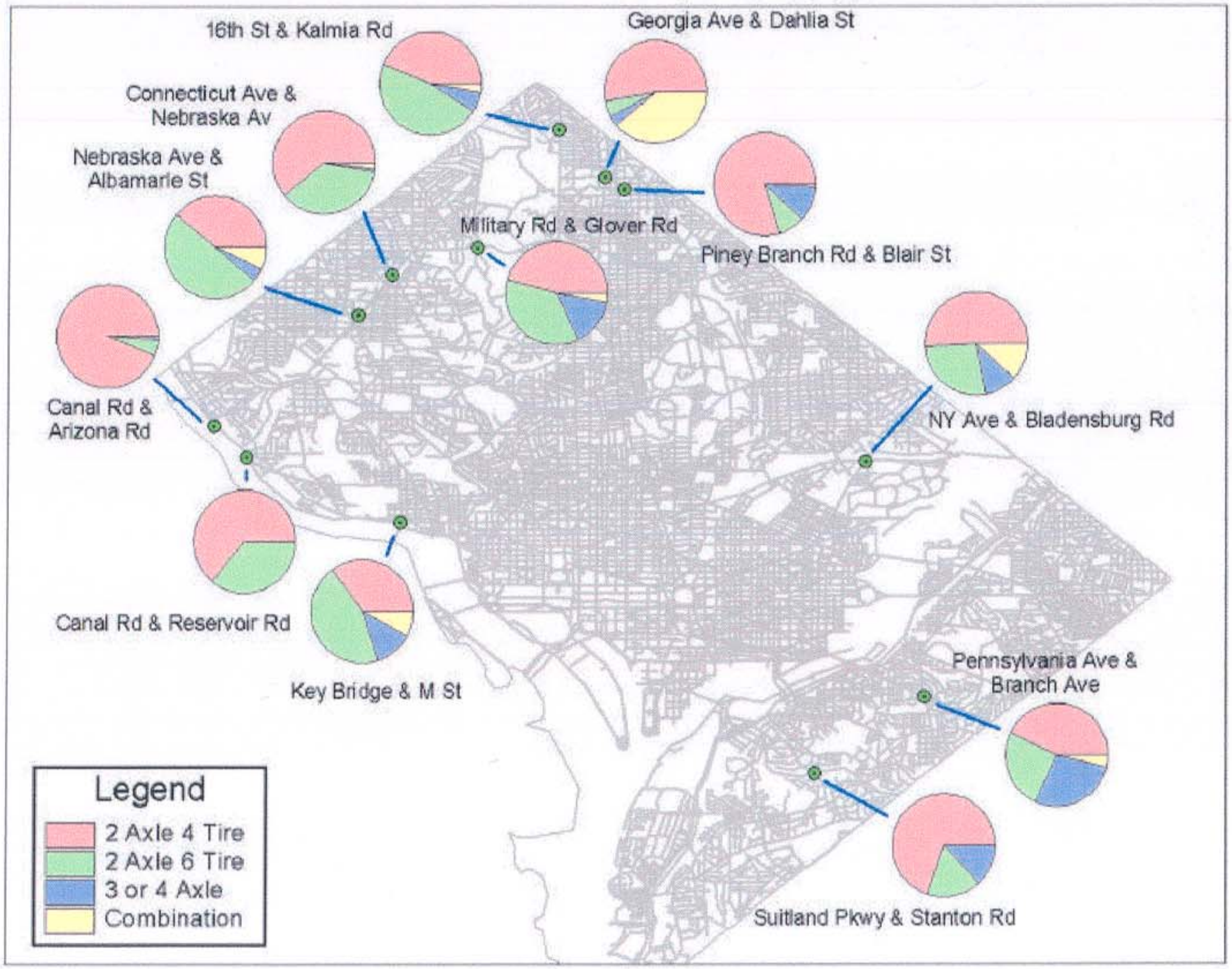
For outbound traffic, over 75 percent of trucks leaving the District between 3 PM and 8 PM leave via the District's eastern and southern borders with Maryland, as shown in Figure 7.

In summary, the data show that more trucks enter the District from Maryland than from Virginia. Also, inbound and outbound truck traffic is heavily concentrated to the east and south of the District.

2.3.2 Truck Traffic Composition by Size

Figures 8 and 9 show the distribution of trucks by size at the locations shown in Table 2. To simplify the analysis, FHWA classes 5-13 have been collapsed into five categories as shown in Table 3.

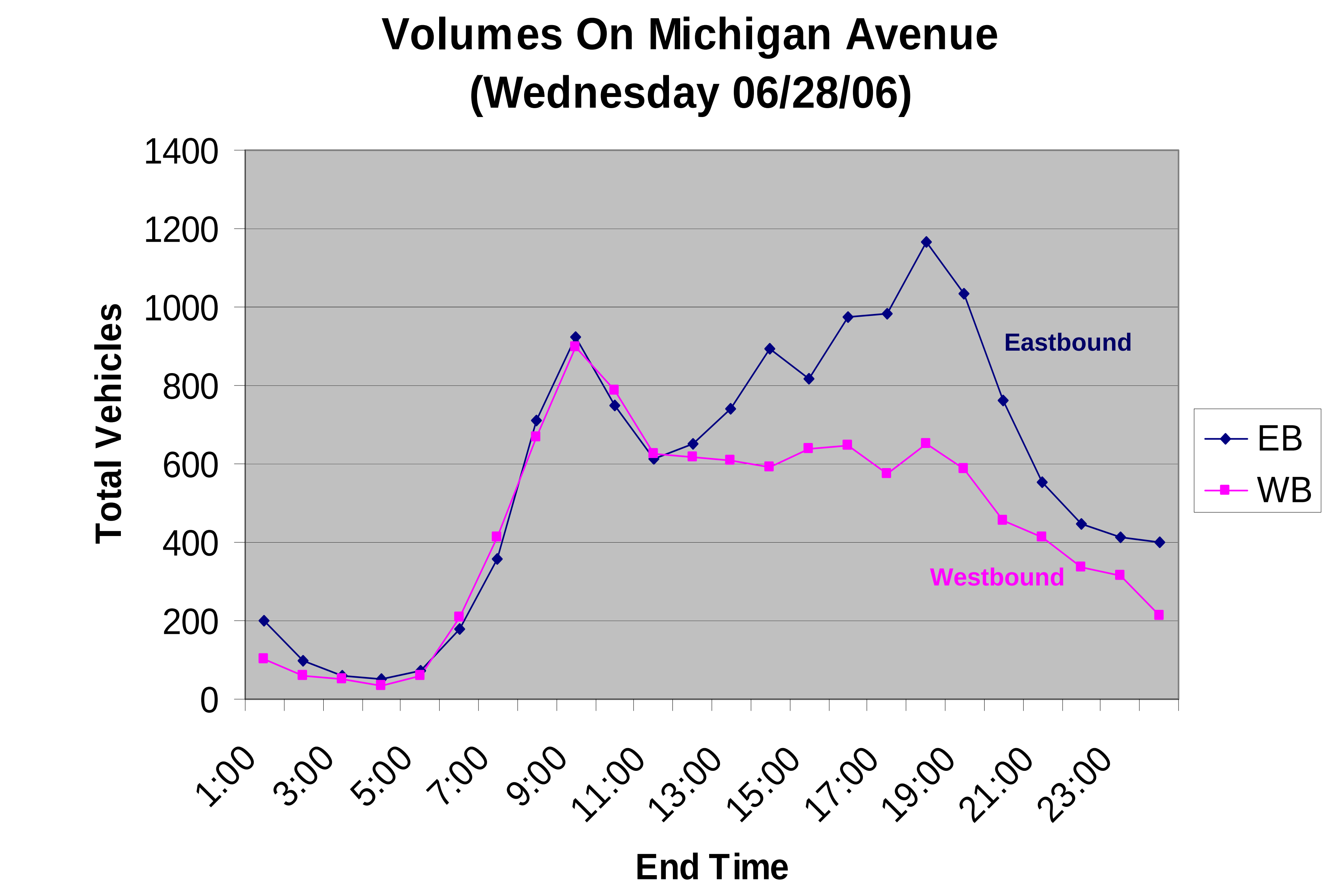
Figure 8. Average Daily Truck Traffic Composition: Inbound



ATTACHMENT

3

TYPICAL WEEKDAY VOLUMES
ON MICHIGAN AVENUE
NEAR FIRST STREET



O. R. GEORGE & ASSOCIATES, INC.

Traffic Engineers - Transportation Planners

ATTACHMENT 3

Typical Weekday Volumes on Michigan Avenue Near First Street – McMillan Water Filtration Plant, Northwest, Washington, D.C.

O. R. GEORGE & ASSOCIATES, INC.

Traffic Engineers – Transportation Planners

10210 Greenbelt Road, Suite 310 • Lanham, MD 20706-2218
Tel: (301) 794-7700 • Fax: (301) 794-4400
E-mail: ogeorge@orgengineering.com

March 28, 2007

Dr. David A. Cornwell, Principal
Environmental Engineering & Technology, Inc.
712 Gum Rock Court
Newport News, VA 23606

Re: Truck Traffic Impact Assessment - Regarding Chemical Processing Changes for Dalecarlia Water Treatment Plant, Northwest Washington, DC

Dear Dr. Cornwell:

In accordance with your request, we have examined the traffic-related impacts associated with the proposal by the United States Corps of Engineers (The COE) to modify the chemical process for the Dalecarlia Water Treatment Plant. More specifically, we note that the COE plans to increase the haulage of chemicals by trucks to the plant in order to change the mix of chemicals involved in the treatment process. The program would increase the number of trucks under the following two (2) options:

Projected Monthly Truck Activity (Truck Deliveries)

Dalecarlia WTP Process Changes	Present Conditions	Future Conditions	Net Changes
1) On-Site Generation Option			
a) Average Monthly	14 Truck Loads	18 Truck Loads	(+4 Truck Loads)
b) Maximum Monthly	16 Truck Loads	22 Truck Loads	(+6 Truck Loads)
2) All-Delivery Option			
a) Average Monthly	14 Truck Loads	45 Truck Loads	(+31 Truck Loads)
b) Maximum Monthly	16 Truck Loads	58 Truck Loads	(+42 Truck Loads)

Source: EE&T Engineers, Inc., and O. R. George & Associates, Inc.

While this memorandum does not address the chemical aspects of the planned changes, it is relevant to note that the variations in projected truck/haulage activity are based upon the expected variances in the quality of water to be treated. It is also important to note that the site has considerable storage capacity, which would allow for considerable flexibility in the "spread" of haulage activity over the days of the month, as well as the time of day. Further description of the existing and alternative scenarios are included in Attachment 1; and the remainder of this memorandum presents our assessment of the likely impact of the alternative program scenarios on the local environment of the Dalecarlia Water Treatment Plant. For ease of reference, the location of the plant is shown as Exhibit 1 (on page 2).

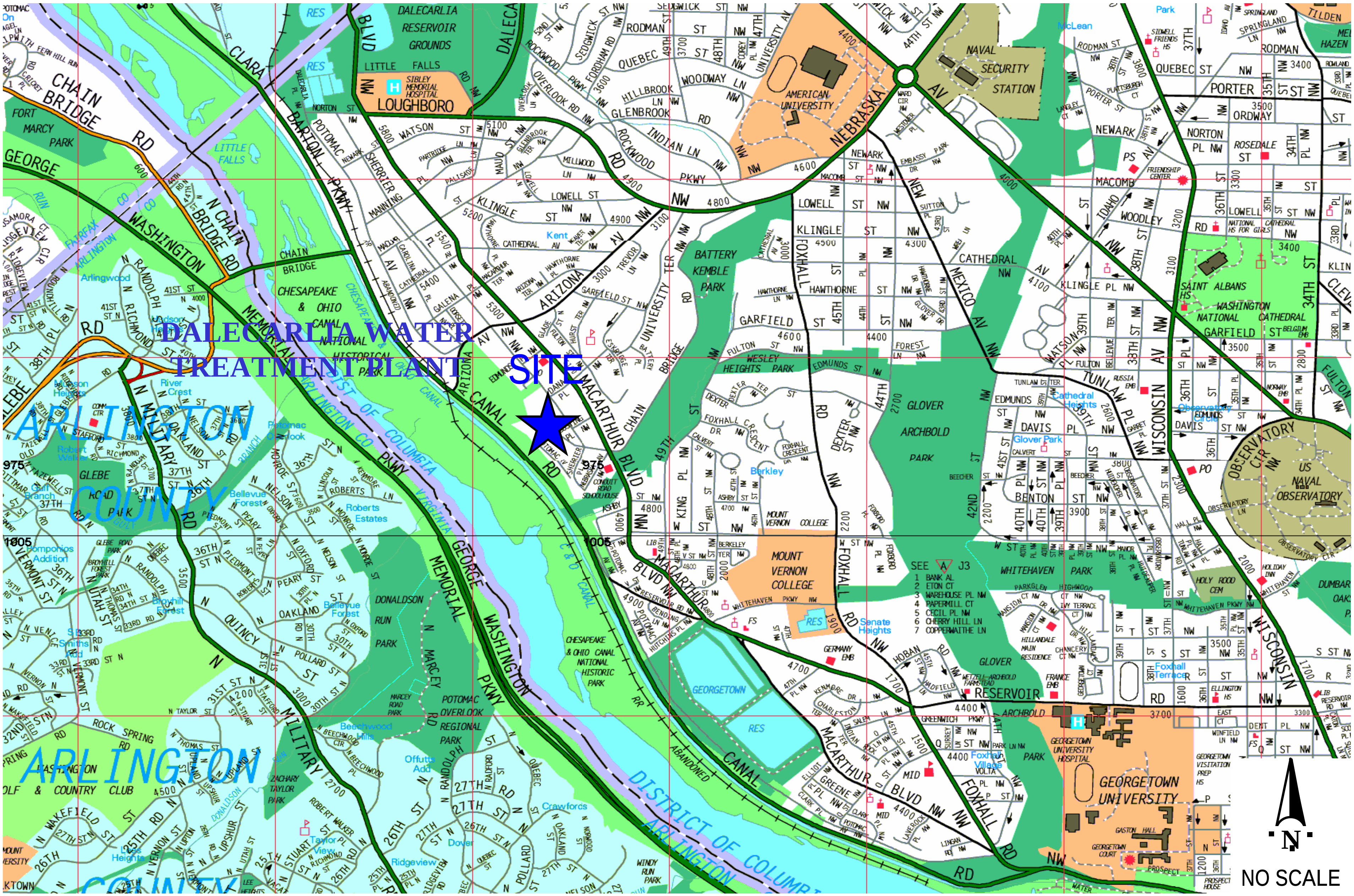


EXHIBIT 1

SITE LOCATION MAP – DALECARLIA WATER TREATMENT PLANT, NORTHWEST, WASHINGTON, D.C.

O. R. GEORGE & ASSOCIATES, INC.

Traffic Engineers - Transportation Planners

Local Area Site Access Situation – (Dalecarlia)

The Dalecarlia plant is situated west of MacArthur Boulevard, in the west Georgetown/Palisades area of Northwest Washington, D.C. MacArthur Boulevard is designated as a Major Arterial facility on the City's functional classification map. Data presented in the recently published Final Environmental Impact Statement for Dalecarlia[1] show the following as principal "indices" of the physical operational characteristics of transportation systems serving the area, and that could potentially be impacted by the proposed action.

a) Traffic volumes along roadways such as MacArthur Boulevard Western Avenue, and Dalecarlia Parkway have remained relatively stable or declined in recent years.

b) Most intersections within the vicinity of the plant currently operate at quite acceptable levels of service.[2]

c) The potential routes identified for truck/haulage activity were predominantly toward the north and the northwest via major arterial-type roadways to the Beltway (I-495).

Relevant aspects of the opportunities for trucks accessing the Dalecarlia plant are also presented in the District of Columbia "Motor Carrier" Study[3]. Some of these are highlighted below:

i) The District does not have designated "truck routes" but notable recognized (de facto) truck routes within the impact area of the Dalecarlia WTP include MacArthur Boulevard, Wisconsin Avenue, Key Bridge, and Massachusetts Avenue.

ii) There are no truck restriction signs posted for other arterial and major collector roadways in the vicinity of the Dalecarlia WTP.

iii) There are no major Truck deliveries Generators within the vicinity of the Dalecarlia WTP. It is also relevant to note that for the proposed Dalecarlia sledge dewatering process, trucks hauling materials would be restricted from using MacArthur Boulevard to the north. Approximately 80% of truck trips access the City from the northeast, and southwest via the major Freeway systems connecting the Beltway (I-95/495 and the US 50 Corridors).

iv) Truck composition data identified for the Canal and Reservoir Road observation locations show the combined percentage of all truck types to be of 0.90% on an average daily basis.

---

[1] Final Environmental Impact Statement for a proposed Water Treatment Residential Management Process for the Washington Aqueduct, Washington D.C. (US Army Corps of Engineers, Baltimore District) 2005.

[2] Level-of-Service is qualitative measure that describes operational conditions within a traffic stream on a roadway segment or at an intersection, and reflects the perception by drivers and other roadway users. Principal level-of-service considerations are speed, travel time, delay and freedom of maneuver, traffic interruptions, comfort convenience and safety. Current engineering practice defines six (6) levels of services (A-F), with "A" representing best operating conditions, and "F" representing the worst conditions. Level of Service "D" is generally considered by the District of Columbia as the minimum acceptable standard for planning and design purposes.

[3] "District of Columbia Motor Carrier Management and Threat Assessment Study" District Department of Transportation, and US Department of Transportation Research and Special Project Administration (August 2004).

More specifically, vehicle classification surveys performed as part of the EIS show the following levels of truck usage.

Representative Roadway Section	**Two-Way Traffic Volumes**		
	Average Weekday	**AM Peak Hour**	**PM Peak Hour**
1) MacArthur Boulevard (North of Reservoir Road)	19,655 (1.1%)	1,885 (1.6%)	1,490 (1.3%)
2) MacArthur Boulevard (South of Loughboro Road)	14,210 (0.7%)	1,184 (0.1%)	1,093 (0.6%)
3) Dalecarlia Parkway (North of Loughboro Road)	15,013 (0.2%)	899 (0.5%)	1,155 (0.1%)

x,xxx = Average Daily Traffic (weekday)
(x.x%) = Percentage of Trucks (Based upon vehicle classification counts)
Source: EIS and O. R. George & Associates.

In addition to the above data, this assessment reviewed the data and analysis presented in the "Environmental Impact Statement" for the proposed changes in the dewatering process at the Dalecarlia WTP. The EIS examined the level of residual production and trucking activity that would be associated with various dewatering alternatives. The EIS report projected conditions over a twenty-year period (to 2024), and estimated the following daily truck deliveries generation under the two (2) most intense (i.e., high impact) alternatives for average conditions:

Design Event Scenario	**Required Trucks/day (Assumed at 5 Days /week)**
a) Maximum month conditions @ one month per year ……………………………	13 Truck Loads/Day
b) Average daily conditions………………………...	8 Truck Loads/Day

The report also noted that under the worst case scenarios, of wet year design processing conditions, the proposed action would produce between 11 and 33 truck deliveries per day. The EIS concluded that various haul routes would be available, allowing for a favorable distribution of traffic; and the report concluded that the proposed dewatering process would have no significant impact on future traffic conditions within the local area of impact. Furthermore, the EIS concluded that the dewatering process would have no significant impact.

Summary Assessment and Conclusion (Proposed Action)

As noted earlier, the treatment alternatives under consideration will generate a net average daily increase of six (6) trucks under the *"On-Site Generation" [Maximum monthly conditions]*, and forty-two (42) truck deliveries per month under the *"All-Delivery Option" [maximum monthly conditions]*. Further details are provided on page 1 and Attachment 1. This level of truck deliveries generated would be equivalent to an average of less than two (2) truck deliveries per day under the high (all-delivery) impact alternative. It was noted that the plant provides for considerable on-site materials storage, allowing flexibility for dispersal of truck deliveries per the loads shown. Furthermore, these deliveries can be scheduled to occur outside of the typical weekday peak hours of commuter traffic (i.e., between 9:30 AM and 4:00 PM).

It is also worthy of note that it is a standard industry practice that truck operators seek opportunities to operate their equipment during off-peak hours in view of the reduced delays experienced, and the associated reduction in operating costs.

Being located within a developed/residential area of the City, clearly additional developments will occur within the area. This includes the planned changes within the Sibley Memorial Hospital site. However, the impacts of these developments are primarily related to weekday peak hour traffic conditions. Even considering their cumulative impacts, the assessment made regarding impacts of the changes at the Dalecarlia Water Treatment Plant would not change. In any case, it is also noted that the planning studies for these developments (such as the Sibley Memorial Hospital expansion) all assume some additional growth in the traffic from other local sources as well as from through traffic. A passenger car equivalency (pce) factor of 2.0 to 3.0 has been considered in this assessment. Even so, there would be no change in the assessed impact. It is also noteworthy that trucks would be restricted from using MacArthur Boulevard north of the site of the proposed action.

In conclusion, this assessment notes that the level of potential increase in truck traffic falls well within the typical daily and peak period fluctuations in traffic. Accordingly, both scenarios under consideration can be accommodated on the local area road network, and should have no significant impact on the transportation–related elements of the local environment. This refers particularly to vehicular delays, noise and emissions. With a further eye toward mitigation, the management of the Dalecarlia Water Treatment Plant should seek to schedule deliveries outside of the typical weekday peak hours wherever practical.

We trust that this satisfies your current requirements. Thank you.

Sincerely,
O. R. GEORGE & ASSOCIATES, INC.

Osborne R. George
President

ORG/wa

Attachments: As Noted

cc: Mr. James F. Day

ATTACHMENT 1

EE&T, Inc.

Consulting Engineers & Architects

Date: January 4, 2007

Osborne George
O.R. George & Associates, INC.
Engineering Memorandum No. 1
EE&T Project No. 3608

Subject: Chemical Deliveries

Purpose

The purpose of this memorandum is to provide the transportation engineer information regarding the expected increase in truck traffic associated with pH control chemicals (lime, caustic soda, and sulfuric acid) and disinfection chemicals (chlorine gas, sodium hypochlorite, salt) at the Dalecarlia and McMillan water treatment plants while still using alum as the coagulant. Below are the addresses of the two plants, average delivery estimates in Tables 1 and 2, and maximum delivery estimates in Tables 3 and 4.

1. Dalecarlia Water Treatment Plant
   5900 MacArthur Boulevard, NW
   Washington, DC 20016-2514

2. McMillan Filtration Plant
   2500 1st Street, NW
   Washington, DC 20001-1022
   (Entrance is located on the West side of 1st St. NW, between Channing St. NW and Michigan Ave. NW)

Table 1. Average monthly deliveries for pH control and disinfection chemicals ($C1_2$ gas, NaOCl)

	Present Conditions			**Recommended Alternatives**			
	Cl_2 Gas	Lime	**Total**	NaOCl	Lime, Caustic Soda, Sulfuric Acid	**Total**	**Increase Over Present Conditions**
Dalecarlia	7	7	**14**	37	8	**45**	**31**
McMillan	4	3	**7**	21	3	**24**	**17**

Table 2. Average monthly deliveries for pH control and disinfection chemicals (Cl_2 gas, NaCl)

	Present Conditions			**Recommended Alternatives**			
	Cl_2 Gas	Lime	**Total**	On-site	Lime, Caustic Soda, Sulfuric Acid	**Total**	**Increase over present conditions**
Dalecarlia	7	7	**14**	10	8	**18**	**4**
McMillan	4	3	**7**	6	3	**9**	**2**

Table 3. Maximum monthly deliveries for pH control and disinfection chemicals ($C1_2$ gas, NaOCl)

	Present Conditions			Recommended Alternatives			
	Cl_2 Gas	Lime	**Total**	NaOCl	Lime, Caustic Soda, Sulfuric Acid	**Total**	**Increase over present conditions**
Dalecarlia	9	7	**16**	50	8	**58**	**42**
McMillan	5	3	**8**	26	3	**29**	**21**

Table 4. Maximum monthly deliveries for pH control and disinfection chemicals (Cl_2 gas, NaCl)

	Present Conditions			Recommended Alternatives			
	Cl_2 Gas	Lime	**Total**	On-site	Lime, Caustic Soda, Sulfuric Acid	**Total**	**Increase over present conditions**
Dalecarlia	9	7	**16**	14	8	**22**	**6**
McMillan	5	3	**8**	7	3	**10**	**2**

Conclusion

The present conditions scenario for this analysis was calculated using the two plants' current operating schemes. This was compared to the number of truck deliveries projected for the recommended pH control alternatives, and using either delivered sodium hypochlorite in Tables 1 and 3 or on-site generation in Tables 2 and 4, as described in the feasibility study. Included are lime, caustic soda, salt, and sodium hypochlorite deliveries for Dalecarlia, and sulfuric acid, caustic soda, salt, and sodium hypochlorite deliveries for McMillan. The anticipated pH control chemical deliveries (lime, caustic soda, sulfuric acid) may come in a variety of combinations depending on the pH of the raw water and the time of year. The maximum delivery estimates for disinfection chemicals were based on the 90th percentile of historical chlorine usage. No peaking factor was applied to the pH adjusting chemical estimates because the storage provided for these chemicals significantly exceeds the average monthly demand.

Tables 1 through 4 show the predicted truckloads per month delivered in bulk tank trucks usually incorporating 5,000 gallon tanks. The truckload calculations were based upon the trucks carrying 24 ton-loads of product as indicated by the chemical manufacturers as a reasonable maximum load weight. The chlorine gas deliveries were calculated based on trucks carrying a maximum load of 13 one-ton cylinders.

ATTACHMENT 2

FINAL ENVIRONMENTAL IMPACT STATEMENT FOR A PROPOSED WATER TREATMENT RESIDUALS MANAGEMENT PROCESS FOR THE WASHINGTON AQUEDUCT, WASHINGTON, D.C.

US Army Corps of Engineers
Baltimore District

VOLUME 1
FINAL ENVIRONMENTAL IMPACT STATEMENT

Prepared by: **U.S. Army Corps of Engineers, Baltimore District**
Washington Aqueduct
5900 MacArthur Boulevard
Washington, D.C. 20016

September 2005

ATTACHMENT 3

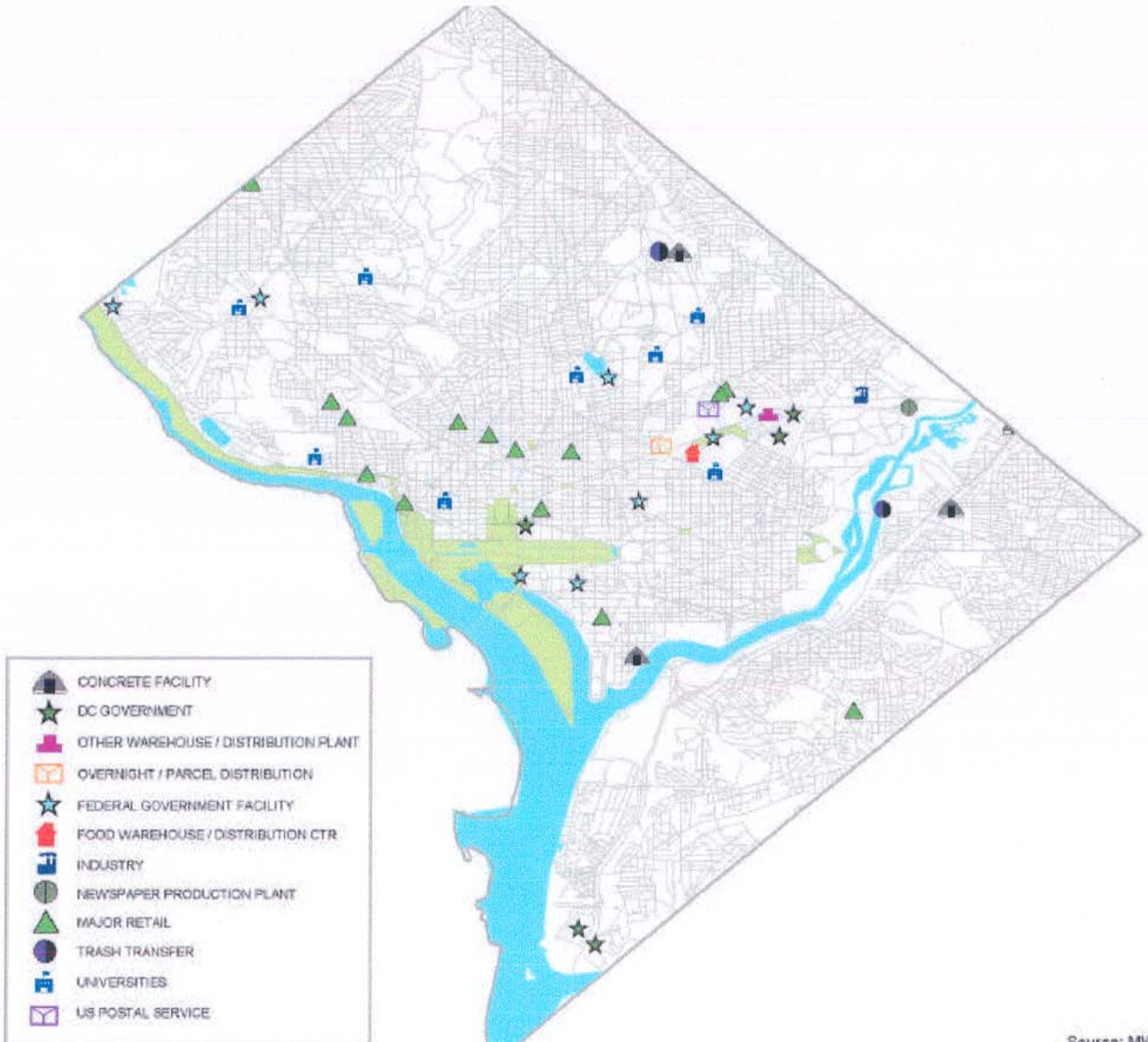
Final Report
August 2004

District of Columbia Motor Carrier Management and Threat Assessment Study

DISTRICT DEPARTMENT OF TRANSPORTATION

U.S. Department of Transportation
Research and Special Projects Administration
Volpe National Transportation Systems Center

Figure 3. Major Truck Trip Generators in the District



Source: MWCOG

DDOT provided manual counts for several locations in the District. For this study, Volpe picked count locations close to the District border in order to analyze inbound and outbound truck trips. Consultant DMJM Harris performed the manual counts for 8, 10, or 12 hours and then extrapolated 24-hour estimates from these counts. Table 2 shows the traffic composition in selected locations near the District borders based on these data. New York Avenue, Georgia Avenue, Kenilworth Avenue, and Suitland Parkway show the highest absolute volumes of truck traffic. Georgia Avenue and Piney Branch Road[2] have the greatest percentages of truck traffic among all the locations for which data are available: about 19 percent and 12 percent inbound and 15 percent and 12 percent outbound, respectively.

Table 2. Traffic Composition in Washington, DC: Inbound and Outbound

Location	Inbound			Outbound		
	Total Vehicles	Trucks	Percentage Trucks	Total Vehicles	Trucks	Percentage Trucks
16th St & Kalmia Rd NW	15,827	309	1.95%	14,602	396	2.71%
New York Ave & Bladensburg Rd NE	45,538	3,567	7.83%	45,007	3,485	7.74%
Georgia Ave NW (between Dahlia & Butternut St. NW)	12,060	2,235	18.53%	14,008	2,097	14.97%
Piney Brach Rd NW (between Blair Rd & Cedar St NW)	6,437	802	12.45%	6,800	801	11.78%
Connecticut & Nebraska Ave NW	18,863	859	4.55%	16,745	709	4.23%
Military & Glover Rd NW	15,877	518	3.26%	17,945	627	3.49%
Nebraska Ave & Albemarle St NW	12,715	182	1.43%	2,997	49	1.64%
Canal & Reservoir Rd NW	3,995	25	0.63%	4,798	55	1.15%
Canal Rd & Arizona Ave NW	24,647	778	3.16%	12,442	248	1.99%
Key Bridge & M St NW	23,700	482	2.03%	NA	NA	NA
Interstate 66	53,000	530	1.00%	47,000	470	1.00%
Interstate 395	107,000	270	0.25%	102,000	2,480	2.43%
Route 29 - Lee Highway	25,000	250	1.00%	NA	NA	NA
Pennsylvania & Branch Ave SE	18,748	1,072	5.72%	28,815	2,411	8.37%
Suitland Parkway & Stanton Rd SE	25,408	1,026	4.04%	26,600	1,419	5.33%

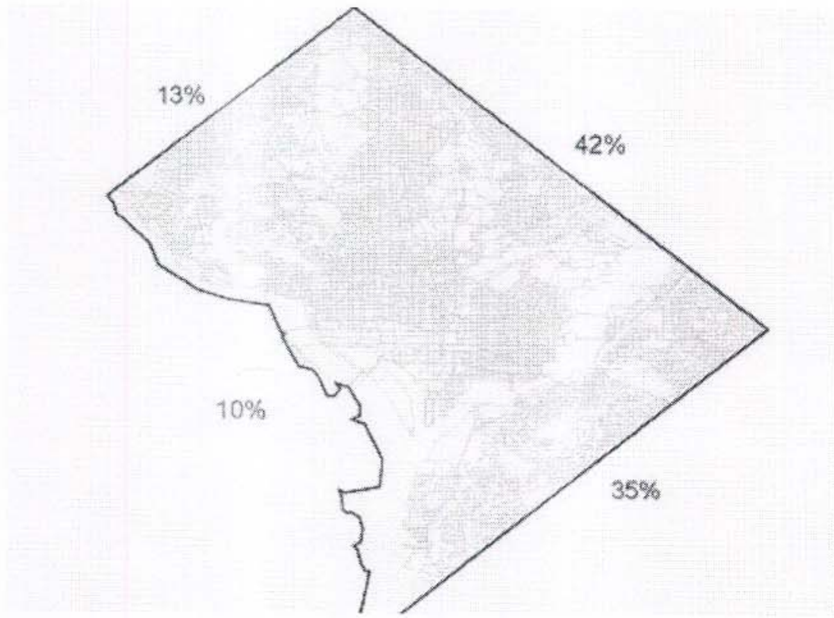
Figure 6 shows how inbound truck traffic is spread along the District border based on the percentage of total truck traffic entering the District from each of its four "sides."[3] More

[2] The high truck volumes on Piney Branch Road are probably a result of street reconstruction in the area and not a reflection of chronic high truck traffic on this roadway.

[3] In the absence of 24-hour counts on every major truck route (including Kenilworth and Rhode Island Avenues for which only AM and PM peak counts are available from MWCOG), the total number of trucks entering the District during any given period cannot be calculated. The data for Figures 6 and 7 were adjusted to account for incomplete cordon line counts. However, this introduces additional opportunity for error. The values in the figures should be taken as estimates of general trends rather than as exact percentages.

than 40 percent of trucks entering the District come in via the northeastern border with Maryland. This is expected since the Maryland suburbs to the east of the District and the eastern part of the District are home to many warehouses and transfer points, particularly along New York Avenue and in the Landover and Lanham, Maryland, areas. Additionally, truck traffic from Baltimore, New York City, and other locations on the Eastern Shore enters the District from the east. There is also substantial truck traffic from Maryland into southeast Washington.

Figure 6. Entrance Points for Inbound Truck Traffic



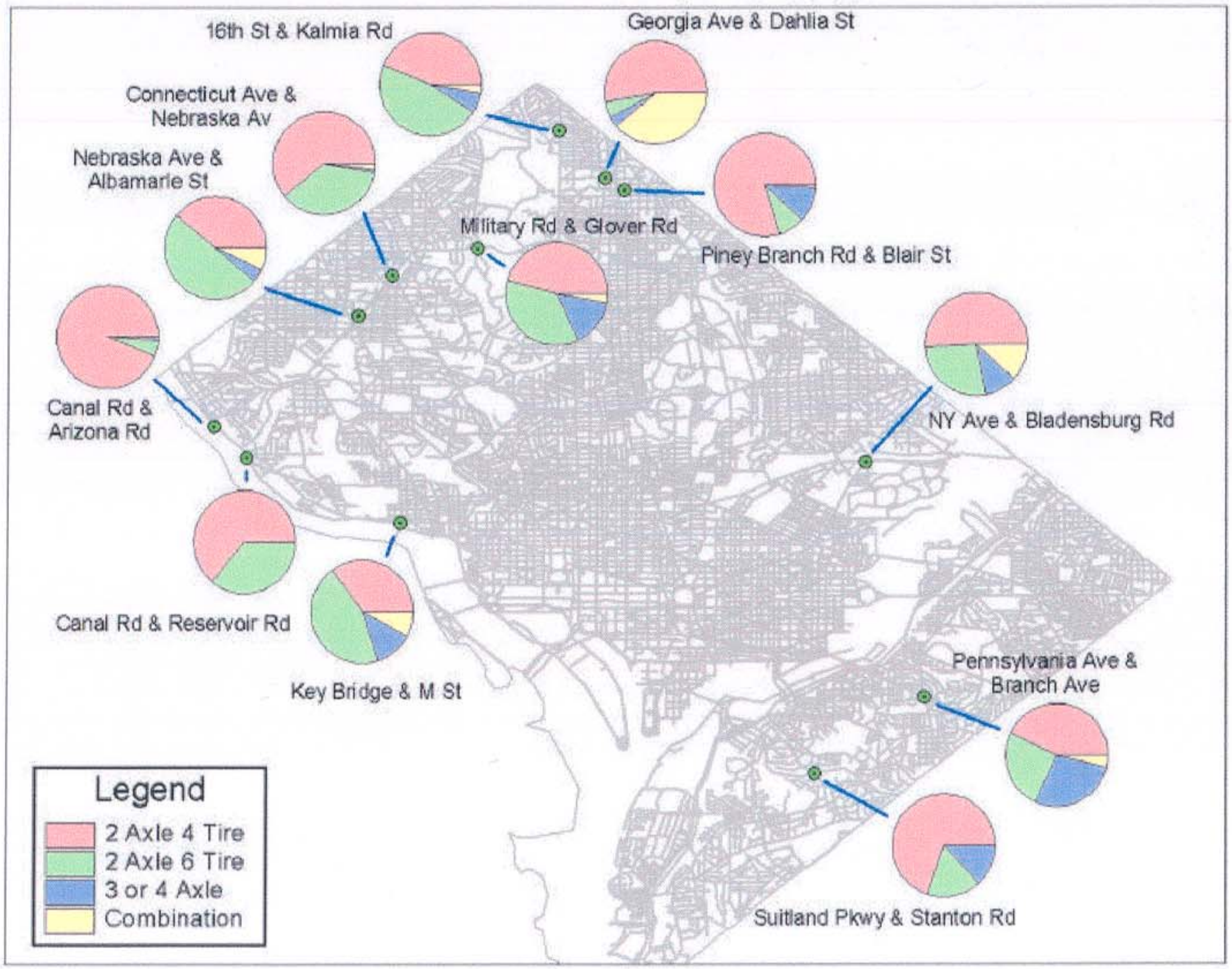
For outbound traffic, over 75 percent of trucks leaving the District between 3 PM and 8 PM leave via the District's eastern and southern borders with Maryland, as shown in Figure 7.

In summary, the data show that more trucks enter the District from Maryland than from Virginia. Also, inbound and outbound truck traffic is heavily concentrated to the east and south of the District.

2.3.2 Truck Traffic Composition by Size

Figures 8 and 9 show the distribution of trucks by size at the locations shown in Table 2. To simplify the analysis, FHWA classes 5-13 have been collapsed into five categories as shown in Table 3.

Figure 8. Average Daily Truck Traffic Composition: Inbound



Appendix G. Supplementary Cost Estimate Memorandum

CENAB-WA-EN 9 MARCH 2007

MEMORANDUM FOR RECORD

RE: Supplementary Cost Analysis for System Improvements of the Dalecarlia WTP and McMillan WTP for Disinfection and pH Control

1. Reference: Feasibility Study for Sodium Hypochlorite and Caustic Soda Facilities, Environmental Engineering and Technology, Inc. (2007).

2. The Feasibility Study for Sodium Hypochlorite and Caustic Soda Facilities (Feasibility Study), included analysis of costs for a variety of alternatives including various uses of existing facilities or construction of new facilities, the use of factory-built tanks or field-built tanks, storage of 6% concentrations or 12% concentrations of bulk hypochlorite, and the generation of dilute hypochlorite on-site as an alternative to receiving bulk hypochlorite deliveries. The storage assumption that was used in order to estimate the size and cost of the different potential facilities incorporating the different aforementioned features was sufficient for approximately 45 days at the design flow and average disinfectant dose when considering the use of bulk hypochlorite, and from one to two days for dilute hypochlorite potentially generated on-site. Based on the practices of other facilities, these assumptions may be overly conservative. Therefore the cost estimates were modified to consider the potential costs associated with implementation of the proposed action while using smaller storage quantities. Additionally, the budgeted amount of the project is $13 million. All potential combinations of the alternatives proposed in the feasibility study exceed the budgeted amount. The no-action alternative, not expressly addressed in the feasibility study, would require no capital funds and would therefore be the only alternative that could meet the budget, unless smaller storage volumes are considered.

3. For the revised cost estimates, only factory-built tanks and storage of 12% bulk hypochlorite or 0.8% dilute hypochlorite generated on-site were considered. Since the storage volumes are smaller and the temperatures in the storage areas were assumed to be controlled, degradation of 12% hypochlorite was presumed to occur slowly enough to be at acceptable levels.

4. Dalecarlia Hypochlorite:

a. Construction of a new facility is necessary for the Dalecarlia WTP if the existing chlorine storage building is to be used for storing caustic soda. However, the new facility can be reduced in size from what was considered in the feasibility study if less bulk hypochlorite is to be stored. The height of the building as presented in the Feasibility Study was maintained in the modified cost estimates, so the depth and volume of 12-FT diameter tanks remained 23.67-FT and 20,000-GAL, respectively. If the building size were reduced to approximately 4,400-SF, up to 12 factory-built tanks could be accommodated. Fewer tanks and on-site hypochlorite generation equipment could also be accommodated in a structure the same size.

b. The 15-day storage requirement for 12% bulk hypochlorite at design flow and average disinfectant dose is 104,000-GAL. To meet this 15-day requirement, with an extra tank for redundancy, seven factory-built tanks would be required. The modified cost estimate for seven tanks (140,000-GAL) is $5.6 million. The modified cost estimate for eight tanks (160,000-GAL) is $5.8 million. The modified cost estimate for nine tanks (180,000) is $6.1 million. The modified cost estimate for ten tanks (200,000-GAL) is $6.4 million. The modified cost estimate for 11 tanks (220,000-GAL) is $6.6 million. The modified cost estimate for 12 tanks (240,000-GAL) is $6.9 million.

c. The cost estimate for on-site generation of hypochlorite in the Feasibility Study includes storage for 1.5 days in three tanks. If one tank were to be out of service, the storage would be sufficient for one day at the design flow and average dose. The same storage requirement can be achieved with the 4,400-SF structure with eight tanks storing 0.8% hypochlorite and two tanks storing sodium chloride brine. There would be remaining space for the on-site generation equipment. The modified cost estimate for on-site generation with the reduced-sized structure is $16.6 million.

5. McMillan Hypochlorite:

a. It is geometrically possible to fit up to nine 12-FT diameter factory-built tanks in the existing chlorine storage building at the McMillan WTP, with sufficient room to remove and replace each tank with new factory-built tanks. The volume of these 12-FT diameter tanks, with an 18.5-FT sidewall depth, is 15,600-GAL. Therefore, it is possible to store up to approximately 140,000-GAL in factory-built tanks in the existing chlorine storage building.

b. The 15-day storage requirement for 12% bulk hypochlorite at design flow and average disinfectant dose is 51,000-GAL. To meet this 15-day requirement, with an extra tank for redundancy, five factory-built tanks would be required. The modified cost estimate to incorporate five tanks (78,000-GAL) is $2.3 million. The modified cost estimate to incorporate six tanks (93,600-GAL) is $2.5 million. The modified cost estimate to incorporate seven tanks (109,200-GAL) is $2.8 million. The modified cost estimate to incorporate eight tanks (124,000-GAL) is $3.1 million. The modified cost estimate to incorporate nine tanks (140,400-GAL) is $3.3 million.

c. The cost estimate in the Feasibility Study for on-site generation of hypochlorite included storage for 1.5 days (assuming one tank was out of service) at the design flow and average disinfectant dose. The existing chlorine storage building was used in the cost estimate. The estimate is appropriately conservative and economical, so modification was not necessary reduce storage volumes. The cost estimate for this alternative in the Feasibility Study is $9.0 million.

6. Dalecarlia Caustic Soda: The estimated cost for construction of four caustic soda tanks in the existing chlorine storage building was used unadjusted, assuming temporary storage and feed of

caustic soda following decommissioning of the existing liquid chlorine system. The cost estimate is $2.5 million. For full caustic feed, using storage in the same existing chlorine storage building, nine tanks would be required. The adjusted cost estimate for full caustic is $3.4 million.

7. McMillan Caustic Soda and Sulfuric Acid: The required storage volumes were reduced from 24,000-GAL to 21,000-GAL for caustic soda and from 6,000-GAL to 3,000-GAL for sulfuric acid. For the sulfuric acid system, the approximate 30 day storage requirement at the design flow and average dose is approximately 1,400-GAL. By reducing the number of tanks for sulfuric acid storage from two to one, redundancy is significantly reduced, however due to the very small volume requirements, in the event of a tank failure, a temporary back up storage system would be necessary. The adjusted cost estimate is $2.4 million.

8. The spreadsheets listing the basis for the revised cost estimates are attached as an Appendix to this memorandum. The total estimated capital costs of each possible combination of alternatives (excluding the no-action alternative) are shown in Table 1. Only three of the 70 possible combinations of alternatives shown in the matrix meet the budgeted amount of $13 million.

9. O&M Costs: Based on the estimated annual operating and maintenance costs including expected equipment replacement (O&M costs) over a 20-year period, a present value analysis was presented in the Feasibility Study for alternatives involving hypochlorite. The O&M cost estimates presented in the Feasibility Study are still representative of the corresponding alternatives even though the capital cost estimates were revised. O&M costs for pH control chemicals were not presented in the Feasibility Study, however they are presented in Table 2 and Table 3. Estimates were based on 2007 prices, but adjusted to estimate 2009 money by an annual discount factor of 6%.

a. Although pre-coagulation pH depression if polyaluminum chloride were to be used was presented in the Feasibility Study, currently polyaluminum chloride is not used by the Washington Aqueduct. Therefore, only the pH control scenario with aluminum sulfate as the coagulant is presented in these O&M costs.

b. Estimates of the O&M costs for the pH control chemicals were based on estimated median doses at the average plant flow, lime cost of $0.0546 per pound, and caustic soda costs and sulfuric costs as presented in the Feasibility Study. Labor rates were assumed to be $41 for both maintenance and operations in 2007 money. Annual operational labor hours were approximated to be 550 for Dalecarlia WTP for lime and caustic trimming, and 365 for both plants for caustic soda only. For full caustic, annual labor hours needed for maintenance at the Dalecarlia WTP and the McMillan WTP were approximated to be 265 and 150 hours, respectively. For lime with caustic trimming, annual labor hours needed for maintenance at the Dalecarlia WTP were approximated to be 740 hours. Caustic trimming is not possible at the McMillan WTP, based on the analysis presented in the Feasibility Study, so there is no capital or O&M cost estimates presented for caustic trimming at the McMillan WTP. Annual maintenance material costs were approximated to be $10,000, $7,000 and $5,000 in 2007 money respectively for Dalecarlia WTP using lime and caustic trimming, for Dalecarlia WTP using caustic soda only, and for McMillan WTP using caustic soda only.

c. Estimates of the O&M costs for liquid chlorine are presented in Table 2 and Table 3 for comparison purposes. For the estimates, the cost of liquid chlorine was assumed to be $0.275 per pound and labor rates were assumed to be $41 for both maintenance and operations in 2007 money. Annual labor hours needed for maintenance at the Dalecarlia WTP and the McMillan WTP were approximated to be 4,100 and 2,050 hours, respectively. Annual maintenance material costs were approximated to be $50,000 in 2007. Annual labor hours needed for maintenance at the Dalecarlia WTP and the McMillan WTP were approximated to be 1,500 at both plants.

10. The present worth analysis, including estimated capital and present worth for replacement costs as well as present value of annual O&M costs, with the combinations of alternatives are presented in Table 1 (in parentheses).

11. Considering the life cycle estimates in the present worth analysis, the least expensive options involve on-site generation of hypochlorite at both plants, the use of lime and caustic soda trimming for pH control at the Dalecarlia WTP, and the use of only caustic soda for pH control at the McMillan WTP; this combination of alternatives, however, exceeds the project capital budget by approximately $17.5 million. Compared to the combinations of alternatives with capital cost within the budgeted project amount of $13 million, the least expensive combination is lower by approximately $5 to $5.2 million over the 20-year time period. However, the life cycle estimates are based on unpredictable variables such as energy and chemical prices, so the actual life cycle costs may vary significantly.

MICHAEL C. PETERSON
Environmental Engineer

CARL AUFDENKAMPE
Structural Engineer

Table 1 Matrix of estimated capital costs (and estimated present value costs considering estimated present worth of annual operational and maintenance costs over 20 years with present value replacement of some equipment) for possible combinations of alternatives satisfying the proposed action objective. Values are presented in millions of dollars (present value costs shown in parenthesis).

		Dalecarlia WTP													
		7 Hypochlorite Tanks	8 Hypochlorite Tanks	9 Hypochlorite Tanks	10 Hypochlorite Tanks	11 Hypochlorite Tanks	12 Hypochlorite Tanks	On-Site Hypochlorite Generation	7 Hypochlorite Tanks	8 Hypochlorite Tanks	9 Hypochlorite Tanks	10 Hypochlorite Tanks	11 Hypochlorite Tanks	12 Hypochlorite Tanks	On-Site Hypochlorite Generation
		Caustic Trim	Caustic Trim	Caustic Trim	Caustic Trim	Caustic Trim	Caustic Trim	Caustic Trim	Full Caustic	Full Caustic	Full Caustic	Full Caustic	Full Caustic	Full Caustic	Full Caustic
McMillan WTP	5 Hypochlorite Tanks, Full Caustic	$12.8 ($57)	$13.0 ($57.2)	$13.3 ($57.5)	$13.6 ($57.8)	$13.8 ($58)	$14.1 ($58.3)	$23.8 ($53.4)	$13.7 ($59.2)	$13.9 ($59.4)	$14.2 ($59.7)	$14.5 ($60)	$14.7 ($60.2)	$15.0 ($60.5)	$24.7 ($55.6)
	6 Hypochlorite Tanks, Full Caustic	$13.0 ($57.2)	$13.2 ($57.4)	$13.5 ($57.7)	$13.8 ($58)	$14.0 ($58.2)	$14.3 ($58.5)	$24.0 ($53.6)	$13.9 ($59.4)	$14.1 ($59.6)	$14.4 ($59.9)	$14.7 ($60.2)	$14.9 ($60.4)	$15.2 ($60.7)	$24.9 ($55.8)
	7 Hypochlorite Tanks, Full Caustic	$13.3 ($57.5)	$13.5 ($57.7)	$13.8 ($58)	$14.1 ($58.3)	$14.3 ($58.5)	$14.6 ($58.8)	$24.3 ($53.9)	$14.2 ($59.7)	$14.4 ($59.9)	$14.7 ($60.2)	$15.0 ($60.5)	$15.2 ($60.7)	$15.5 ($61)	$25.2 ($56.1)
	8 Hypochlorite Tanks, Full Caustic	$13.6 ($57.8)	$13.8 ($58)	$14.1 ($58.3)	$14.4 ($58.6)	$14.6 ($58.8)	$14.9 ($59.1)	$24.6 ($54.2)	$14.5 ($60)	$14.7 ($60.2)	$15.0 ($60.5)	$15.3 ($60.8)	$15.5 ($61)	$15.8 ($61.3)	$25.5 ($56.4)
	9 Hypochlorite Tanks, Full Caustic	$13.8 ($58)	$14.0 ($58.2)	$14.3 ($58.5)	$14.6 ($58.8)	$14.8 ($59)	$15.1 ($59.3)	$24.8 ($54.4)	$14.7 ($60.2)	$14.9 ($60.4)	$15.2 ($60.7)	$15.5 ($61)	$15.7 ($61.2)	$16.0 ($61.5)	$25.7 ($56.6)
	On-Site Hypochlorite Generation, Full Caustic	$19.5 ($55.6)	$19.7 ($55.8)	$20 ($56.1)	$20.3 ($56.4)	$20.5 ($56.6)	$20.8 ($56.9)	$30.5 ($52)	$20.4 ($57.8)	$20.6 ($58)	$20.9 ($58.3)	$21.2 ($58.6)	$21.4 ($58.8)	$21.7 ($59.1)	$31.4 ($54.2)

Table 2 Estimated present worth of annual operation and maintenance costs and present value replacement for alternatives at the Dalecarlia WTP.

Alternative	Annual O&M Costs		Present Worth of Annual O&M	Present Value Replacement
	Operations	Maintenance		
Liquid Chlorine	$668,000	$235,000	$10,400,000	NA
12% Bulk Hypochlorite	$2,094,000	$4,000	$24,000,000	$315,000
6% Bulk Hypochlorite	$2,128,000	$13,000	$24,600,000	$595,000
On-Site Generation	$784,000	$30,000	$9,300,000	$365,000
Lime and Caustic Trimming	$232,000	$45,000	$3,200,000	$50,000
Full Caustic	$376,000	$20,000	$4,500,000	$75,000

Table 3 Estimated present worth of annual operation and maintenance costs and present value replacement for alternatives at the McMillan WTP.

Alternative	Annual O&M Costs		Present Worth of Annual O&M	Present Value Replacement
	Operations	Maintenance		
Liquid Chlorine	$414,000	$89,000	$5,800,000	NA
12% Bulk Hypochlorite	$1,176,000	$4,000	$13,500,000	$150,000
6% Bulk Hypochlorite	$1,201,000	$13,000	$13,900,000	$281,000
On-Site Generation	$443,000	$18,000	$5,300,000	$253,000
Full Caustic and Sulfuric Acid	$132,000	$108,000	$2,800,000	$65,000

Environmental Engineering and Technology, Inc.

Project:	**DALECARLIA SODIUM HYPOCHLORITE**	Sheet No. :	of
Location:	**DALECARLIA WTP**		
Project No.			
Description:	**NEW BUILDING - 12' DIA. TANKS--7 TRUCKED IN TANKS**		

Design Status: [X] No Design Completed / [ ] Preliminary Design / [ ] Final Design / [ ] Other:

Remarks: **D1 - Drawings** — Done By: DR — Date: 06/20/06

12% SODIUM HYPOCHLOLRITE — Chkd By: DAC — Date: 06/20/06

BUILDING HEIGHT - 34'-6"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	4,400	$150.00	$660,000	$100.00	$440,000		$250.00	$1,100,000
2	HVAC	SF	4,400	$2.00	$8,800	$2.00	$17,600		$4.00	$17,600
3	CONCRETE TANK PADS	CY	44	$270.00	$11,844	$130.00	$5,703		$400.00	$17,547
4	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
5	FRP GRATING	SF	4,200	$25.00	$105,000	$10.00	$42,000		$35.00	$147,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	7	$40,000.00	$280,000	$12,000.00	$84,000		$52,000.00	$364,000
7	FEED PUMPS	EA	4	$20,000.00	$70,000	$6,000.00	$21,000		$26,000.00	$91,000
8	PUMP CONTROL	EA	4	$15,000.00	$52,500	$15,000.00	$52,500		$30,000.00	$105,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	994	$32.00	$31,808	$10.00	$9,940		$42.00	$41,748
13	3" LINED DUCTILE VALVES	EA	14	$725.00	$10,150	$500.00	$7,000		$1,225.00	$17,150
14	2" LINED STEEL PIPING	LF	994	$25.00	$24,850	$10.00	$9,940		$35.00	$34,790
15	2" LINED STEEL VALVES	EA	14	$425.00	$5,950	$500.00	$7,000		$925.00	$12,950
16	3" PVC TANK DRAIN	LF	994	$5.00	$4,970	$5.00	$4,970		$10.00	$9,940
17	3" PVC TANK DRAIN VALVES	EA	7	$260.00	$1,820	$100.00	$700		$360.00	$2,520
18	8" PVC TANK VENTS	EA	7	$600.00	$4,200	$300.00	$2,100		$900.00	$6,300
19	FLOW METERS	EA	2	$8,500.00	$20,400	$3,000.00	$7,200		$11,500.00	$27,600
20	LEVEL SENSORS	EA	7	$2,000.00	$14,000	$600.00	$4,200		$2,600.00	$18,200
21	**DISTRIBUTION PIPING**									
22	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
23	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
24	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
25	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
26	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
27	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
28	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
29	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
30	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
31	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
32	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
33										
34										
35	SUB-TOTAL				$1,342,107		$822,524			$2,164,631
36	5% SALE TAX				$67,105					
37	50% LABOR BURDEN						$411,262			
38										
39	SUB-TOTAL				$1,409,212		$1,233,785			$2,642,998
40	5% SUB BOND & INS (50% OF PROJECT)									$66,075
41										
42	SUB-TOTAL									$2,709,073
43	10% SUB O/H (50% OF PROJECT)									$135,454
44										
45	SUB-TOTAL									$2,844,526
46	10% SUB PROFIT (50% OF PROJECT)									$142,226
47										
48	SUB-TOTAL									$2,986,753
49	5% PRIME BOND AND INS									$149,338
50										
51	SUB-TOTAL									$3,136,090
52	10% PRIME O/H									$313,609
53										
54	SUB-TOTAL									$3,449,699
55	10% PRIME PROFIT									$344,970
56										
57	SUB-TOTAL									$3,794,669
58	5% MOB / DEMOB									$189,733
59										
60	SUB-TOTAL									$3,984,403
61	25% CONTINGENCY									$996,101
62										
63	TOTAL									$4,980,503
64										
65	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$5,568,986

Environmental Engineering and Technology, Inc.

Project: DALECARLIA SODIUM HYPOCHLORITE — Sheet No. : ____ of ____
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 12' DIA. TANKS--8 TRUCKED IN TANKS

Design Status: [X] No Design Completed; [ ] Preliminary Design; [ ] Final Design; [ ] Other:

Remarks: **D1 - Drawings** — Done By: DR — Date: 06/20/06

12% SODIUM HYPOCHLOLRITE — Chkd By: DAC — Date: 06/20/06

BUILDING HEIGHT - 34'-6"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	4,400	$150.00	$660,000	$100.00	$440,000		$250.00	$1,100,000
2	HVAC	SF	4,400	$2.00	$8,800	$2.00	$17,600		$4.00	$17,600
3	CONCRETE TANK PADS	CY	50	$270.00	$13,536	$130.00	$6,517		$400.00	$20,053
4	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
5	FRP GRATING	SF	4,200	$25.00	$105,000	$10.00	$42,000		$35.00	$147,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	8	$40,000.00	$320,000	$12,000.00	$96,000		$52,000.00	$416,000
7	FEED PUMPS	EA	4	$20,000.00	$80,000	$6,000.00	$24,000		$26,000.00	$104,000
8	PUMP CONTROL	EA	4	$15,000.00	$60,000	$15,000.00	$60,000		$30,000.00	$120,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	1,136	$32.00	$36,352	$10.00	$11,360		$42.00	$47,712
13	3" LINED DUCTILE VALVES	EA	16	$725.00	$11,600	$500.00	$8,000		$1,225.00	$19,600
14	2" LINED STEEL PIPING	LF	1,136	$25.00	$28,400	$10.00	$11,360		$35.00	$39,760
15	2" LINED STEEL VALVES	EA	16	$425.00	$6,800	$500.00	$8,000		$925.00	$14,800
16	3" PVC TANK DRAIN	LF	1,136	$5.00	$5,680	$5.00	$5,680		$10.00	$11,360
17	3" PVC TANK DRAIN VALVES	EA	8	$260.00	$2,080	$100.00	$800		$360.00	$2,880
18	8" PVC TANK VENTS	EA	8	$600.00	$4,800	$300.00	$2,400		$900.00	$7,200
19	FLOW METERS	EA	3	$8,500.00	$22,950	$3,000.00	$8,100		$11,500.00	$31,050
20	LEVEL SENSORS	EA	8	$2,000.00	$16,000	$600.00	$4,800		$2,600.00	$20,800
21	**DISTRIBUTION PIPING**									
22	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
23	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
24	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
25	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
26	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
27	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
28	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
29	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
30	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
31	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
32	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
33										
34										
35	SUB-TOTAL				$1,417,813		$853,288			$2,271,101
36	5% SALE TAX				$70,891					
37	50% LABOR BURDEN						$426,644			
38										
39	SUB-TOTAL				$1,488,704		$1,279,931			$2,768,635
40	5% SUB BOND & INS (50% OF PROJECT)									$69,216
41										
42	SUB-TOTAL									$2,837,851
43	10% SUB O/H (50% OF PROJECT)									$141,893
44										
45	SUB-TOTAL									$2,979,743
46	10% SUB PROFIT (50% OF PROJECT)									$148,987
47										
48	SUB-TOTAL									$3,128,731
49	5% PRIME BOND AND INS									$156,437
50										
51	SUB-TOTAL									$3,285,167
52	10% PRIME O/H									$328,517
53										
54	SUB-TOTAL									$3,613,684
55	10% PRIME PROFIT									$361,368
56										
57	SUB-TOTAL									$3,975,052
58	5% MOB / DEMOB									$198,753
59										
60	SUB-TOTAL									$4,173,805
61	25% CONTINGENCY									$1,043,451
62										
63	TOTAL									$5,217,256
64										
65	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$5,833,713

Environmental Engineering and Technology, Inc.

Project: DALECARLIA SODIUM HYPOCHLORITE — Sheet No. : ____ of ____
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 12' DIA. TANKS--9 TRUCKED IN TANKS

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: D1 - Drawings — Done By: DR — Date: 06/20/06
12% SODIUM HYPOCHLOLRITE — Chkd By: DAC — Date: 06/20/06
BUILDING HEIGHT - 34'-6"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	4,400	$150.00	$660,000	$100.00	$440,000		$250.00	$1,100,000
2	HVAC	SF	4,400	$2.00	$8,800	$2.00	$17,600		$4.00	$17,600
3	CONCRETE TANK PADS	CY	56	$270.00	$15,228	$130.00	$7,332		$400.00	$22,560
4	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
5	FRP GRATING	SF	4,200	$25.00	$105,000	$10.00	$42,000		$35.00	$147,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	9	$40,000.00	$360,000	$12,000.00	$108,000		$52,000.00	$468,000
7	FEED PUMPS	EA	5	$20,000.00	$90,000	$6,000.00	$27,000		$26,000.00	$117,000
8	PUMP CONTROL	EA	5	$15,000.00	$67,500	$15,000.00	$67,500		$30,000.00	$135,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	1,278	$32.00	$40,896	$10.00	$12,780		$42.00	$53,676
13	3" LINED DUCTILE VALVES	EA	18	$725.00	$13,050	$500.00	$9,000		$1,225.00	$22,050
14	2" LINED STEEL PIPING	LF	1,278	$25.00	$31,950	$10.00	$12,780		$35.00	$44,730
15	2" LINED STEEL VALVES	EA	18	$425.00	$7,650	$500.00	$9,000		$925.00	$16,650
16	3" PVC TANK DRAIN	LF	1,278	$5.00	$6,390	$5.00	$6,390		$10.00	$12,780
17	3" PVC TANK DRAIN VALVES	EA	9	$260.00	$2,340	$100.00	$900		$360.00	$3,240
18	8" PVC TANK VENTS	EA	9	$600.00	$5,400	$300.00	$2,700		$900.00	$8,100
19	FLOW METERS	EA	3	$8,500.00	$25,500	$3,000.00	$9,000		$11,500.00	$34,500
20	LEVEL SENSORS	EA	9	$2,000.00	$18,000	$600.00	$5,400		$2,600.00	$23,400
21	**DISTRIBUTION PIPING**									
22	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
23	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
24	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
25	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
26	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
27	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
28	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
29	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
30	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
31	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
32	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
33										
34										
35	SUB-TOTAL				$1,493,519		$884,053			$2,377,572
36	5% SALE TAX				$74,676					
37	50% LABOR BURDEN						$442,026			
38										
39	SUB-TOTAL				$1,568,195		$1,326,079			$2,894,274
40	5% SUB BOND & INS (50% OF PROJECT)									$72,357
41										
42	SUB-TOTAL									$2,966,631
43	10% SUB O/H (50% OF PROJECT)									$148,332
44										
45	SUB-TOTAL									$3,114,962
46	10% SUB PROFIT (50% OF PROJECT)									$155,748
47										
48	SUB-TOTAL									$3,270,710
49	5% PRIME BOND AND INS									$163,536
50										
51	SUB-TOTAL									$3,434,246
52	10% PRIME O/H									$343,425
53										
54	SUB-TOTAL									$3,777,670
55	10% PRIME PROFIT									$377,767
56										
57	SUB-TOTAL									$4,155,437
58	5% MOB / DEMOB									$207,772
59										
60	SUB-TOTAL									$4,363,209
61	25% CONTINGENCY									$1,090,802
62										
63	TOTAL									$5,454,012
64										
65	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$6,098,443

Environmental Engineering and Technology, Inc.

Project: DALECARLIA SODIUM HYPOCHLORITE — Sheet No. : ______ of ______
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 12' DIA. TANKS--10 TRUCKED IN TANKS

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: **D1 - Drawings** — Done By: DR — Date: 06/20/06
12% SODIUM HYPOCHLOLRITE — Chkd By: DAC — Date: 06/20/06
BUILDING HEIGHT - 34'-6"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	4,400	$150.00	$660,000	$100.00	$440,000		$250.00	$1,100,000
2	HVAC	SF	4,400	$2.00	$8,800	$2.00	$17,600		$4.00	$17,600
3	CONCRETE TANK PADS	CY	63	$270.00	$16,920	$130.00	$8,147		$400.00	$25,067
4	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
5	FRP GRATING	SF	4,200	$25.00	$105,000	$10.00	$42,000		$35.00	$147,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	10	$40,000.00	$400,000	$12,000.00	$120,000		$52,000.00	$520,000
7	FEED PUMPS	EA	5	$20,000.00	$100,000	$6,000.00	$30,000		$26,000.00	$130,000
8	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000		$30,000.00	$150,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	1,420	$32.00	$45,440	$10.00	$14,200		$42.00	$59,640
13	3" LINED DUCTILE VALVES	EA	20	$725.00	$14,500	$500.00	$10,000		$1,225.00	$24,500
14	2" LINED STEEL PIPING	LF	1,420	$25.00	$35,500	$10.00	$14,200		$35.00	$49,700
15	2" LINED STEEL VALVES	EA	20	$425.00	$8,500	$500.00	$10,000		$925.00	$18,500
16	3" PVC TANK DRAIN	LF	1,420	$5.00	$7,100	$5.00	$7,100		$10.00	$14,200
17	3" PVC TANK DRAIN VALVES	EA	10	$260.00	$2,600	$100.00	$1,000		$360.00	$3,600
18	8" PVC TANK VENTS	EA	10	$600.00	$6,000	$300.00	$3,000		$900.00	$9,000
19	FLOW METERS	EA	3	$8,500.00	$28,900	$3,000.00	$10,200		$11,500.00	$39,100
20	LEVEL SENSORS	EA	10	$2,000.00	$20,000	$600.00	$6,000		$2,600.00	$26,000
21	**DISTRIBUTION PIPING**									
22	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
23	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
24	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
25	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
26	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
27	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
28	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
29	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
30	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
31	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
32	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
33										
34										
35	SUB-TOTAL				$1,570,075		$915,118			$2,485,193
36	5% SALE TAX				$78,504					
37	50% LABOR BURDEN						$457,559			
38										
39	SUB-TOTAL				$1,648,579		$1,372,676			$3,021,255
40	5% SUB BOND & INS (50% OF PROJECT)									$75,531
41										
42	SUB-TOTAL									$3,096,787
43	10% SUB O/H (50% OF PROJECT)									$154,839
44										
45	SUB-TOTAL									$3,251,626
46	10% SUB PROFIT (50% OF PROJECT)									$162,581
47										
48	SUB-TOTAL									$3,414,207
49	5% PRIME BOND AND INS									$170,710
50										
51	SUB-TOTAL									$3,584,918
52	10% PRIME O/H									$358,492
53										
54	SUB-TOTAL									$3,943,409
55	10% PRIME PROFIT									$394,341
56										
57	SUB-TOTAL									$4,337,750
58	5% MOB / DEMOB									$216,888
59										
60	SUB-TOTAL									$4,554,638
61	25% CONTINGENCY									$1,138,659
62										
63	TOTAL									$5,693,297
64										
65	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$6,366,002

Project: DALECARLIA SODIUM HYPOCHLORITE | Sheet No. : ______ of ______
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - 12' DIA. TANKS--11 TRUCKED IN TANKS

Design Status: [X] No Design Completed
[ ] Preliminary Design
[ ] Final Design
[ ] Other:

Remarks: **D1 - Drawings** — Done By: DR — Date: 06/20/06
12% SODIUM HYPOCHLOLRITE — Chkd By: DAC — Date: 06/20/06
BUILDING HEIGHT - 34'-6"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	4,400	$150.00	$660,000	$100.00	$440,000		$250.00	$1,100,000
2	HVAC	SF	4,400	$2.00	$8,800	$2.00	$17,600		$4.00	$17,600
3	CONCRETE TANK PADS	CY	69	$270.00	$18,612	$130.00	$8,961		$400.00	$27,573
4	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
5	FRP GRATING	SF	4,200	$25.00	$105,000	$10.00	$42,000		$35.00	$147,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	11	$40,000.00	$440,000	$12,000.00	$132,000		$52,000.00	$572,000
7	FEED PUMPS	EA	6	$20,000.00	$110,000	$6,000.00	$33,000		$26,000.00	$143,000
8	PUMP CONTROL	EA	6	$15,000.00	$82,500	$15,000.00	$82,500		$30,000.00	$165,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	1,562	$32.00	$49,984	$10.00	$15,620		$42.00	$65,604
13	3" LINED DUCTILE VALVES	EA	22	$725.00	$15,950	$500.00	$11,000		$1,225.00	$26,950
14	2" LINED STEEL PIPING	LF	1,562	$25.00	$39,050	$10.00	$15,620		$35.00	$54,670
15	2" LINED STEEL VALVES	EA	22	$425.00	$9,350	$500.00	$11,000		$925.00	$20,350
16	3" PVC TANK DRAIN	LF	1,562	$5.00	$7,810	$5.00	$7,810		$10.00	$15,620
17	3" PVC TANK DRAIN VALVES	EA	11	$260.00	$2,860	$100.00	$1,100		$360.00	$3,960
18	8" PVC TANK VENTS	EA	11	$600.00	$6,600	$300.00	$3,300		$900.00	$9,900
19	FLOW METERS	EA	4	$8,500.00	$31,450	$3,000.00	$11,100		$11,500.00	$42,550
20	LEVEL SENSORS	EA	11	$2,000.00	$22,000	$600.00	$6,600		$2,600.00	$28,600
21	**DISTRIBUTION PIPING**									
22	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
23	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
24	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
25	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
26	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
27	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
28	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
29	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUD	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
30	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
31	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
32	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
33										
34										
35	SUB-TOTAL				$1,645,781		$945,882			$2,591,663
36	5% SALE TAX				$82,289					
37	50% LABOR BURDEN						$472,941			
38										
39	SUB-TOTAL				$1,728,070		$1,418,822			$3,146,892
40	5% SUB BOND & INS (50% OF PROJECT)									$78,672
41										
42	SUB-TOTAL									$3,225,565
43	10% SUB O/H (50% OF PROJECT)									$161,278
44										
45	SUB-TOTAL									$3,386,843
46	10% SUB PROFIT (50% OF PROJECT)									$169,342
47										
48	SUB-TOTAL									$3,556,185
49	5% PRIME BOND AND INS									$177,809
50										
51	SUB-TOTAL									$3,733,994
52	10% PRIME O/H									$373,399
53										
54	SUB-TOTAL									$4,107,394
55	10% PRIME PROFIT									$410,739
56										
57	SUB-TOTAL									$4,518,133
58	5% MOB / DEMOB									$225,907
59										
60	SUB-TOTAL									$4,744,040
61	25% CONTINGENCY									$1,186,010
62										
63	TOTAL									$5,930,050
64										
65	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$6,630,729

Environmental Engineering and Technology, Inc.

Project:	**DALECARLIA SODIUM HYPOCHLORITE**	Sheet No. :	of
Location:	**DALECARLIA WTP**		
Project No.			
Description:	**NEW BUILDING - 12' DIA. TANKS--12 TRUCKED IN TANKS**		

				Design Status:	X	No Design Completed
Remarks:	**D1 - Drawings**	Done By: DR	Date: 06/20/06			Preliminary Design
	12% SODIUM HYPOCHLOLRITE	Chkd By: DAC	Date: 06/20/06			Final Design
	BUILDING HEIGHT - 34'-6"					Other:

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	4,400	$150.00	$660,000	$100.00	$440,000		$250.00	$1,100,000
2	HVAC	SF	4,400	$2.00	$8,800	$2.00	$17,600		$4.00	$17,600
3	CONCRETE TANK PADS	CY	75	$270.00	$20,304	$130.00	$9,776		$400.00	$30,080
4	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
5	FRP GRATING	SF	4,200	$25.00	$105,000	$10.00	$42,000		$35.00	$147,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	12	$40,000.00	$480,000	$12,000.00	$144,000		$52,000.00	$624,000
7	FEED PUMPS	EA	6	$20,000.00	$120,000	$6,000.00	$36,000		$26,000.00	$156,000
8	PUMP CONTROL	EA	6	$15,000.00	$90,000	$15,000.00	$90,000		$30,000.00	$180,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	1,704	$32.00	$54,528	$10.00	$17,040		$42.00	$71,568
13	3" LINED DUCTILE VALVES	EA	24	$725.00	$17,400	$500.00	$12,000		$1,225.00	$29,400
14	2" LINED STEEL PIPING	LF	1,704	$25.00	$42,600	$10.00	$17,040		$35.00	$59,640
15	2" LINED STEEL VALVES	EA	24	$425.00	$10,200	$500.00	$12,000		$925.00	$22,200
16	3" PVC TANK DRAIN	LF	1,704	$5.00	$8,520	$5.00	$8,520		$10.00	$17,040
17	3" PVC TANK DRAIN VALVES	EA	12	$260.00	$3,120	$100.00	$1,200		$360.00	$4,320
18	8" PVC TANK VENTS	EA	12	$600.00	$7,200	$300.00	$3,600		$900.00	$10,800
19	FLOW METERS	EA	4	$8,500.00	$34,000	$3,000.00	$12,000		$11,500.00	$46,000
20	LEVEL SENSORS	EA	12	$2,000.00	$24,000	$600.00	$7,200		$2,600.00	$31,200
21	**DISTRIBUTION PIPING**									
22	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
23	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
24	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
25	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
26	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
27	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
28	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
29	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLUDI	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
30	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
31	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
32	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
33										
34										
35	SUB-TOTAL				$1,721,487		$976,647			$2,698,134
36	5% SALE TAX				$86,074					
37	50% LABOR BURDEN						$488,323			
38										
39	SUB-TOTAL				$1,807,561		$1,464,970			$3,272,531
40	5% SUB BOND & INS (50% OF PROJECT)									$81,813
41										
42	SUB-TOTAL									$3,354,345
43	10% SUB O/H (50% OF PROJECT)									$167,717
44										
45	SUB-TOTAL									$3,522,062
46	10% SUB PROFIT (50% OF PROJECT)									$176,103
47										
48	SUB-TOTAL									$3,698,165
49	5% PRIME BOND AND INS									$184,908
50										
51	SUB-TOTAL									$3,883,073
52	10% PRIME O/H									$388,307
53										
54	SUB-TOTAL									$4,271,380
55	10% PRIME PROFIT									$427,138
56										
57	SUB-TOTAL									$4,698,518
58	5% MOB / DEMOB									$234,926
59										
60	SUB-TOTAL									$4,933,444
61	25% CONTINGENCY									$1,233,361
62										
63	TOTAL									$6,166,805
64										
65	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$6,895,459

Project: DALECARLIA SODIUM HYPOCHLORITE
Location: DALECARLIA WTP
Project No.
Description: NEW BUILDING - ON-SITE GENERATION

Sheet No. : ______ of ______

Design Status:
[X] No Design Completed
[ ] Preliminary Design
[ ] Final Design
[ ] Other:

Remarks: D1 - Drawings — Done By: ______ Date: ______
ON-SITE GENERATION of HYPOCHLORITE — Chkd By: ______ Date: ______
BUILDING HEIGHT - 34'-6"

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	NEW STORAGE BUILDING	SF	4,400	$150.00	$660,000	$100.00	$440,000		$250.00	$1,100,000
2	ELECTRIC	SF	4,400	$4.00	$17,600	$2.00	$35,200		$6.00	$26,400
3	CONCRETE TANK PADS	CY	63	$270.00	$16,920	$130.00	$8,147		$400.00	$25,067
4	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040		$400.00	$3,200
5	FRP GRATING	SF	4,200	$25.00	$105,000	$10.00	$42,000		$35.00	$147,000
6	12' FRP SODIUM HYPOCHLORITE TANKS - 20,000 GALLON	EA	10	$40,000.00	$400,000	$12,000.00	$120,000		$52,000.00	$520,000
7	FEED PUMPS	EA	5	$20,000.00	$100,000	$6,000.00	$30,000		$26,000.00	$130,000
8	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000		$30,000.00	$150,000
9	SCADA CONTROL CABLE AND CONDUIT	LF	900	$5.00	$4,500	$5.00	$4,500		$10.00	$9,000
10	DEMO EXISTING BUILDING	LS	1			$50,000.00	$50,000		$50,000.00	$50,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	1,420	$32.00	$45,440	$10.00	$14,200		$42.00	$59,640
13	3" LINED DUCTILE VALVES	EA	20	$725.00	$14,500	$500.00	$10,000		$1,225.00	$24,500
14	2" LINED STEEL PIPING	LF	1,420	$25.00	$35,500	$10.00	$14,200		$35.00	$49,700
15	2" LINED STEEL VALVES	EA	20	$425.00	$8,500	$500.00	$10,000		$925.00	$18,500
16	3" PVC TANK DRAIN	LF	1,420	$5.00	$7,100	$5.00	$7,100		$10.00	$14,200
17	3" PVC TANK DRAIN VALVES	EA	10	$260.00	$2,600	$100.00	$1,000		$360.00	$3,600
18	8" PVC TANK VENTS	EA	10	$600.00	$6,000	$300.00	$3,000		$900.00	$9,000
19	FLOW METERS	EA	3	$8,500.00	$28,900	$3,000.00	$10,200		$11,500.00	$39,100
20	LEVEL SENSORS	EA	10	$2,000.00	$20,000	$600.00	$6,000		$2,600.00	$26,000
21										
22	**ON-SITE EQUIPMENT**									
23	ON-SITE GENERATION EQUIPMENT (ESTIMATE)	EA	1	$2,150,000.00	$2,150,000	$645,000.00	$645,000		$ 2,795,000.00	$2,795,000
24	BACK-UP GENERATOR (2,250 kW)	EA	1	$350,000.00	$350,000	$350,000.00	$350,000		$ 700,000.00	$700,000
25	AUTOMATIC TRANSFER SWITCH (3000A)	EA	1	$44,000.00	$44,000	$44,000.00	$44,000		$ 88,000.00	$88,000
26	ELECTRICAL SERVICE UPGRADE	LS	1	$361,000.00	$361,000	$137,000.00	$137,000		$ 498,000.00	$498,000
27	**DISTRIBUTION PIPING**									
28	4" SCH 80 PVC	LF	6,920	$3.66	$25,327	$1.10	$7,612		$4.76	$32,939
29	4" SCH 80 90° BEND SxS	EA	11	$16.03	$176	$4.81	$53		$20.84	$229
30	4" SCH 80 45° BEND SxS	EA	10	$43.54	$435	$13.06	$130.60		$56.60	$566
31	TRENCHING 24"W x 36" DEEP	LF	6,920	$0.00	$0	$1.00	$6,920		$1.00	$6,920
32	BEDDING	CY	160	$8.15	$1,304	$6.95	$1,112		$15.10	$2,416
33	COMPACTED BACKFILL	CY	1,356	$0.00	$0	$24.00	$32,544		$24.00	$32,544
34	ASPHALT PAVEMENT REPLACEMENT	SY	51	$7.56	$386	$23.11	$1,179		$30.67	$1,564
35	ASPHALT PAVEMENT SAW CUTTING (BOTH SIDES INCLU	LF	220	$3.00	$660	$6.00	$1,320		$9.00	$1,980
36	4" x 2" (SxS) REDUCING BUSHINGS	EA	7	$40.72	$285	$12.22	$86		$52.94	$371
37	2" x 3/4" (SPGxT) REDUCING BUSHINGS	EA	7	$5.85	$41	$1.76	$12		$7.61	$53
38	3/4" x 3/4" INJECTOR	EA	7	$77.25	$541	$23.18	$162		$100.43	$703
39										
40										
41	SUB-TOTAL				$4,483,875		$2,108,718			$6,592,593
42	5% SALE TAX				$224,194					
43	50% LABOR BURDEN						$1,054,359			
44										
45	SUB-TOTAL				$4,708,069		$3,163,076			$7,871,145
46	5% SUB BOND & INS (50% OF PROJECT)									$196,779
47										
48	SUB-TOTAL									$8,067,924
49	10% SUB O/H (50% OF PROJECT)									$403,396
50										
51	SUB-TOTAL									$8,471,320
52	10% SUB PROFIT (50% OF PROJECT)									$423,566
53										
54	SUB-TOTAL									$8,894,886
55	5% PRIME BOND AND INS									$444,744
56										
57	SUB-TOTAL									$9,339,630
58	10% PRIME O/H									$933,963
59										
60	SUB-TOTAL									$10,273,593
61	10% PRIME PROFIT									$1,027,359
62										
63	SUB-TOTAL									$11,300,953
64	5% MOB / DEMOB									$565,048
65										
66	SUB-TOTAL									$11,866,000
67	25% CONTINGENCY									$2,966,500
68										
69	TOTAL									$14,832,500
70										
71	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$16,585,069

Project: **McMILLAN SODIUM HYPOCHLORITE FEED PIPING** Sheet No. : of

Location: **McMILLAN WTP**

Project No. Estimated LaborCost : 30 %

Description: **EXISTING BUILDING - 12' DIA. TANKS--5 FACTORY BUILT TANKS**

Design Status: [X] No Design Completed

Remarks: **M1 - Drawings** Done By: DR Date: 06/20/06 [ ] Preliminary Design

12% SODIUM HYPOCHLORITE Chkd By: DAC Date: 06/20/06 [ ] Final Design

Existing Building [ ] Other:

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000		$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	60	$270.00	$16,200	$130.00	$7,800		$400.00	$24,000
3	CONCRETE CONTAINMENT CURB	CY	20	$270.00	$5,400	$130.00	$2,600		$400.00	$8,000
4	12' FRP SODIUM HYPOCHLORITE TANKS - 15,600 GALLON	EA	5	$28,000.00	$140,000	$10,000.00	$50,000		$38,000.00	$190,000
5	FRP GRATING	SF	2,840	$25.00	$71,000	$10.00	$28,400		$35.00	$99,400
6	FEED PUMPS	EA	3	$19,000.00	$47,500	$6,000.00	$15,000		$25,000.00	$62,500
7	PUMP CONTROL	EA	3	$15,000.00	$37,500	$15,000.00	$37,500		$30,000.00	$75,000
8	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
10	HVAC IMPROVEMENTS	SF	5,000	$2.00	$10,000	$2.00	$10,000		$4.00	$20,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	2,500	$32.00	$80,000	$10.00	$25,000		$42.00	$105,000
13	3" LINED DUCTILE VALVES	EA	10	$725.00	$7,250	$500.00	$5,000		$1,225.00	$12,250
14	2" LINED STEEL PIPING	LF	1,500	$25.00	$37,500	$10.00	$15,000		$35.00	$52,500
15	2" LINED STEEL VALVES	EA	10	$425.00	$4,250	$500.00	$5,000		$925.00	$9,250
16	3" PVC TANK DRAIN	LF	1,500	$5.00	$7,500	$5.00	$7,500		$10.00	$15,000
17	3" PVC TANK DRAIN VALVES	EA	5	$260.00	$1,300	$100.00	$500		$360.00	$1,800
18	8" PVC TANK VENTS	EA	5	$600.00	$3,000	$300.00	$1,500		$900.00	$4,500
19	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
20	LEVEL SENSORS	EA	5	$2,000.00	$10,000	$600.00	$3,000		$2,600.00	$13,000
21										
22										
22	SUB-TOTAL				$534,400		$336,800			$871,200
23	5% SALE TAX				$26,720					$26,720
24	50% LABOR BURDEN						$168,400			$168,400
25										
26	SUB-TOTAL				$561,120		$505,200			$1,066,320
27	5% SUB BOND & INS (50% of PROJECT)									$26,658
28										
29	SUB-TOTAL									$1,092,978
30	10% SUB O/H (50% of PROJECT)									$54,649
31										
32	SUB-TOTAL									$1,147,627
33	10% SUB PROFIT (50% of PROJECT)									$57,381
34										
35	SUB-TOTAL									$1,205,008
36	5% PRIME BOND AND INS									$60,250
37										
38	SUB-TOTAL									$1,265,259
39	10% PRIME O/H									$126,526
40										
41	SUB-TOTAL									$1,391,785
42	10% PRIME PROFIT									$139,178
43										
44	SUB-TOTAL									$1,530,963
45	5% MOB / DEMOB									$76,548
46										
47	SUB-TOTAL									$1,607,511
48	25% CONTINGENCY									$401,878
49										
50	TOTAL (FEB 2007)									$2,009,389
51										
52	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$2,246,813

Project: **McMILLAN SODIUM HYPOCHLORITE FEED PIPING** Sheet No. : of
Location: **McMILLAN WTP**
Project No. Estimated LaborCost : 30 %
Description: **EXISTING BUILDING - 12' DIA. TANKS--6 FACTORY BUILT TANKS**

Design Status: [X] No Design Completed

Remarks: **M1 - Drawings** Done By: DR Date: 06/20/06 [ ] Preliminary Design

12% SODIUM HYPOCHLORITE Chkd By: DAC Date: 06/20/06 [ ] Final Design

Existing Building [ ] Other:

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000		$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	60	$270.00	$16,200	$130.00	$7,800		$400.00	$24,000
3	CONCRETE CONTAINMENT CURB	CY	20	$270.00	$5,400	$130.00	$2,600		$400.00	$8,000
4	12' FRP SODIUM HYPOCHLORITE TANKS - 15,600 GALLON	EA	6	$28,000.00	$168,000	$10,000.00	$60,000		$38,000.00	$228,000
5	FRP GRATING	SF	2,840	$25.00	$71,000	$10.00	$28,400		$35.00	$99,400
6	FEED PUMPS	EA	3	$19,000.00	$57,000	$6,000.00	$18,000		$25,000.00	$75,000
7	PUMP CONTROL	EA	3	$15,000.00	$45,000	$15,000.00	$45,000		$30,000.00	$90,000
8	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
10	HVAC IMPROVEMENTS	SF	5,000	$2.00	$10,000	$2.00	$10,000		$4.00	$20,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	3,000	$32.00	$96,000	$10.00	$30,000		$42.00	$126,000
13	3" LINED DUCTILE VALVES	EA	12	$725.00	$8,700	$500.00	$6,000		$1,225.00	$14,700
14	2" LINED STEEL PIPING	LF	1,800	$25.00	$45,000	$10.00	$18,000		$35.00	$63,000
15	2" LINED STEEL VALVES	EA	12	$425.00	$5,100	$500.00	$6,000		$925.00	$11,100
16	3" PVC TANK DRAIN	LF	1,800	$5.00	$9,000	$5.00	$9,000		$10.00	$18,000
17	3" PVC TANK DRAIN VALVES	EA	6	$260.00	$1,560	$100.00	$600		$360.00	$2,160
18	8" PVC TANK VENTS	EA	6	$600.00	$3,600	$300.00	$1,800		$900.00	$5,400
19	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
20	LEVEL SENSORS	EA	6	$2,000.00	$12,000	$600.00	$3,600		$2,600.00	$15,600
21										
22										
22	SUB-TOTAL				$609,560		$369,800			$979,360
23	5% SALE TAX				$30,478					$30,478
24	50% LABOR BURDEN						$184,900			$184,900
25										
26	SUB-TOTAL				$640,038		$554,700			$1,194,738
27	5% SUB BOND & INS (50% of PROJECT)									$29,868
28										
29	SUB-TOTAL									$1,224,606
30	10% SUB O/H (50% of PROJECT)									$61,230
31										
32	SUB-TOTAL									$1,285,837
33	10% SUB PROFIT (50% of PROJECT)									$64,292
34										
35	SUB-TOTAL									$1,350,129
36	5% PRIME BOND AND INS									$67,506
37										
38	SUB-TOTAL									$1,417,635
39	10% PRIME O/H									$141,764
40										
41	SUB-TOTAL									$1,559,399
42	10% PRIME PROFIT									$155,940
43										
44	SUB-TOTAL									$1,715,338
45	5% MOB / DEMOB									$85,767
46										
47	SUB-TOTAL									$1,801,105
48	25% CONTINGENCY									$450,276
49										
50	TOTAL (FEB 2007)									$2,251,382
51										
52	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$2,517,399

Project: McMILLAN SODIUM HYPOCHLORITE FEED PIPING | Sheet No. : | of
Location: McMILLAN WTP
Project No. | Estimated LaborCost : 30 %
Description: EXISTING BUILDING - 12' DIA. TANKS--7 FACTORY BUILT TANKS

Design Status: [X] No Design Completed

Remarks: **M1 - Drawings** | Done By: DR | Date: 06/20/06 | [ ] Preliminary Design

12% SODIUM HYPOCHLORITE | Chkd By: DAC | Date: 06/20/06 | [ ] Final Design

Existing Building | [ ] Other:

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000		$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	60	$270.00	$16,200	$130.00	$7,800		$400.00	$24,000
3	CONCRETE CONTAINMENT CURB	CY	20	$270.00	$5,400	$130.00	$2,600		$400.00	$8,000
4	12' FRP SODIUM HYPOCHLORITE TANKS - 15,600 GALLON	EA	7	$28,000.00	$196,000	$10,000.00	$70,000		$38,000.00	$266,000
5	FRP GRATING	SF	2,840	$25.00	$71,000	$10.00	$28,400		$35.00	$99,400
6	FEED PUMPS	EA	4	$19,000.00	$66,500	$6,000.00	$21,000		$25,000.00	$87,500
7	PUMP CONTROL	EA	4	$15,000.00	$52,500	$15,000.00	$52,500		$30,000.00	$105,000
8	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
10	HVAC IMPROVEMENTS	SF	5,000	$2.00	$10,000	$2.00	$10,000		$4.00	$20,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	3,500	$32.00	$112,000	$10.00	$35,000		$42.00	$147,000
13	3" LINED DUCTILE VALVES	EA	14	$725.00	$10,150	$500.00	$7,000		$1,225.00	$17,150
14	2" LINED STEEL PIPING	LF	2,100	$25.00	$52,500	$10.00	$21,000		$35.00	$73,500
15	2" LINED STEEL VALVES	EA	14	$425.00	$5,950	$500.00	$7,000		$925.00	$12,950
16	3" PVC TANK DRAIN	LF	2,100	$5.00	$10,500	$5.00	$10,500		$10.00	$21,000
17	3" PVC TANK DRAIN VALVES	EA	7	$260.00	$1,820	$100.00	$700		$360.00	$2,520
18	8" PVC TANK VENTS	EA	7	$600.00	$4,200	$300.00	$2,100		$900.00	$6,300
19	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
20	LEVEL SENSORS	EA	7	$2,000.00	$14,000	$600.00	$4,200		$2,600.00	$18,200
21										
22										
22	SUB-TOTAL				$684,720		$402,800			$1,087,520
23	5% SALE TAX				$34,236					$34,236
24	50% LABOR BURDEN						$201,400			$201,400
25										
26	SUB-TOTAL				$718,956		$604,200			$1,323,156
27	5% SUB BOND & INS (50% of PROJECT)									$33,079
28										
29	SUB-TOTAL									$1,356,235
30	10% SUB O/H (50% of PROJECT)									$67,812
31										
32	SUB-TOTAL									$1,424,047
33	10% SUB PROFIT (50% of PROJECT)									$71,202
34										
35	SUB-TOTAL									$1,495,249
36	5% PRIME BOND AND INS									$74,762
37										
38	SUB-TOTAL									$1,570,011
39	10% PRIME O/H									$157,001
40										
41	SUB-TOTAL									$1,727,013
42	10% PRIME PROFIT									$172,701
43										
44	SUB-TOTAL									$1,899,714
45	5% MOB / DEMOB									$94,986
46										
47	SUB-TOTAL									$1,994,700
48	25% CONTINGENCY									$498,675
49										
50	TOTAL (FEB 2007)									$2,493,374
51										
52	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$2,787,985

Project:	**McMILLAN SODIUM HYPOCHLORITE FEED PIPING**	Sheet No. :	of
Location:	**McMILLAN WTP**		
Project No.		Estimated LaborCost :	30 %
Description:	**EXISTING BUILDING - 12' DIA. TANKS--8 FACTORY BUILT TANKS**		

Design Status: [X] No Design Completed; [ ] Preliminary Design; [ ] Final Design; [ ] Other:

Remarks: **M1 - Drawings** — Done By: DR — Date: 06/20/06

12% SODIUM HYPOCHLORITE — Chkd By: DAC — Date: 06/20/06

Existing Building

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000		$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	60	$270.00	$16,200	$130.00	$7,800		$400.00	$24,000
3	CONCRETE CONTAINMENT CURB	CY	20	$270.00	$5,400	$130.00	$2,600		$400.00	$8,000
4	12' FRP SODIUM HYPOCHLORITE TANKS - 15,600 GALLON	EA	8	$28,000.00	$224,000	$10,000.00	$80,000		$38,000.00	$304,000
5	FRP GRATING	SF	2,840	$25.00	$71,000	$10.00	$28,400		$35.00	$99,400
6	FEED PUMPS	EA	4	$19,000.00	$76,000	$6,000.00	$24,000		$25,000.00	$100,000
7	PUMP CONTROL	EA	4	$15,000.00	$60,000	$15,000.00	$60,000		$30,000.00	$120,000
8	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
10	HVAC IMPROVEMENTS	SF	5,000	$2.00	$10,000	$2.00	$10,000		$4.00	$20,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	4,000	$32.00	$128,000	$10.00	$40,000		$42.00	$168,000
13	3" LINED DUCTILE VALVES	EA	16	$725.00	$11,600	$500.00	$8,000		$1,225.00	$19,600
14	2" LINED STEEL PIPING	LF	2,400	$25.00	$60,000	$10.00	$24,000		$35.00	$84,000
15	2" LINED STEEL VALVES	EA	16	$425.00	$6,800	$500.00	$8,000		$925.00	$14,800
16	3" PVC TANK DRAIN	LF	2,400	$5.00	$12,000	$5.00	$12,000		$10.00	$24,000
17	3" PVC TANK DRAIN VALVES	EA	8	$260.00	$2,080	$100.00	$800		$360.00	$2,880
18	8" PVC TANK VENTS	EA	8	$600.00	$4,800	$300.00	$2,400		$900.00	$7,200
19	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
20	LEVEL SENSORS	EA	8	$2,000.00	$16,000	$600.00	$4,800		$2,600.00	$20,800
21										
22										
22	SUB-TOTAL				$759,880		$435,800			$1,195,680
23	5% SALE TAX				$37,994					$37,994
24	50% LABOR BURDEN						$217,900			$217,900
25										
26	SUB-TOTAL				$797,874		$653,700			$1,451,574
27	5% SUB BOND & INS (50% of PROJECT)									$36,289
28										
29	SUB-TOTAL									$1,487,863
30	10% SUB O/H (50% of PROJECT)									$74,393
31										
32	SUB-TOTAL									$1,562,257
33	10% SUB PROFIT (50% of PROJECT)									$78,113
34										
35	SUB-TOTAL									$1,640,369
36	5% PRIME BOND AND INS									$82,018
37										
38	SUB-TOTAL									$1,722,388
39	10% PRIME O/H									$172,239
40										
41	SUB-TOTAL									$1,894,627
42	10% PRIME PROFIT									$189,463
43										
44	SUB-TOTAL									$2,084,089
45	5% MOB / DEMOB									$104,204
46										
47	SUB-TOTAL									$2,188,294
48	25% CONTINGENCY									$547,073
49										
50	TOTAL (FEB 2007)									$2,735,367
51										
52	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$3,058,571

Project: **McMILLAN SODIUM HYPOCHLORITE FEED PIPING** Sheet No. : of

Location: **McMILLAN WTP**

Project No. Estimated LaborCost : 30 %

Description: **EXISTING BUILDING - 12' DIA. TANKS--9 FACTORY BUILT TANKS**

Design Status: [X] No Design Completed

Remarks: **M1 - Drawings** Done By: Date: [ ] Preliminary Design

12% SODIUM HYPOCHLORITE Chkd By: Date: [ ] Final Design

Existing Building [ ] Other:

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000		$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	60	$270.00	$16,200	$130.00	$7,800		$400.00	$24,000
3	CONCRETE CONTAINMENT CURB	CY	20	$270.00	$5,400	$130.00	$2,600		$400.00	$8,000
4	12' FRP SODIUM HYPOCHLORITE TANKS - 15,600 GALLON	EA	9	$28,000.00	$252,000	$10,000.00	$90,000		$38,000.00	$342,000
5	FRP GRATING	SF	2,840	$25.00	$71,000	$10.00	$28,400		$35.00	$99,400
6	FEED PUMPS	EA	5	$19,000.00	$85,500	$6,000.00	$27,000		$25,000.00	$112,500
7	PUMP CONTROL	EA	5	$15,000.00	$67,500	$15,000.00	$67,500		$30,000.00	$135,000
8	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$10.00	$10,000
10	HVAC IMPROVEMENTS	SF	5,000	$2.00	$10,000	$2.00	$10,000		$4.00	$20,000
11	**TANK PIPING**									
12	3" LINED STEEL PIPING	LF	4,500	$32.00	$144,000	$10.00	$45,000		$42.00	$189,000
13	3" LINED DUCTILE VALVES	EA	18	$725.00	$13,050	$500.00	$9,000		$1,225.00	$22,050
14	2" LINED STEEL PIPING	LF	2,700	$25.00	$67,500	$10.00	$27,000		$35.00	$94,500
15	2" LINED STEEL VALVES	EA	18	$425.00	$7,650	$500.00	$9,000		$925.00	$16,650
16	3" PVC TANK DRAIN	LF	2,700	$5.00	$13,500	$5.00	$13,500		$10.00	$27,000
17	3" PVC TANK DRAIN VALVES	EA	9	$260.00	$2,340	$100.00	$900		$360.00	$3,240
18	8" PVC TANK VENTS	EA	9	$600.00	$5,400	$300.00	$2,700		$900.00	$8,100
19	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$11,500.00	$69,000
20	LEVEL SENSORS	EA	9	$2,000.00	$18,000	$600.00	$5,400		$2,600.00	$23,400
21										
22										
22	SUB-TOTAL				$835,040		$468,800			$1,303,840
23	5% SALE TAX				$41,752					$41,752
24	50% LABOR BURDEN						$234,400			$234,400
25										
26	SUB-TOTAL				$876,792		$703,200			$1,579,992
27	5% SUB BOND & INS (50% of PROJECT)									$39,500
28										
29	SUB-TOTAL									$1,619,492
30	10% SUB O/H (50% of PROJECT)									$80,975
31										
32	SUB-TOTAL									$1,700,466
33	10% SUB PROFIT (50% of PROJECT)									$85,023
34										
35	SUB-TOTAL									$1,785,490
36	5% PRIME BOND AND INS									$89,274
37										
38	SUB-TOTAL									$1,874,764
39	10% PRIME O/H									$187,476
40										
41	SUB-TOTAL									$2,062,241
42	10% PRIME PROFIT									$206,224
43										
44	SUB-TOTAL									$2,268,465
45	5% MOB / DEMOB									$113,423
46										
47	SUB-TOTAL									$2,381,888
48	25% CONTINGENCY									$595,472
49										
50	TOTAL (FEB 2007)									$2,977,360
51										
52	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)									$3,329,157

Project: McMILLAN SODIUM HYPOCHLORITE
Location: McMILLAN WTP
Project No.
Description: EXISTING BUILDING - 12' DIA. TANKS--TRUCKED TANKS

Sheet No. : of

Estimated LaborCost : 30 %

Design Status: [X] No Design Completed
[ ] Preliminary Design
[ ] Final Design
[ ] Other:

Remarks: **M5 - Drawings** Done By: WG Date: 07/12/06

ON-SITE GENERATION Chkd By: DR Date: 07/12/06

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST		TOTAL UNIT COST	TOTAL COST
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000		$ 100,000.00	$100,000
2	CONCRETE TANK PADS	CY	55	$270.00	$14,850	$130.00	$7,150		$ 400.00	$22,000
3	CONCRETE CONTAINMENT CURB	CY	3	$270.00	$810	$130.00	$390		$ 400.00	$1,200
4	12' FRP SODIUM HYPOCHLORITE TANKS - 15,000 GALLON	EA	6	$28,000.00	$168,000	$10,000.00	$60,000		$ 38,000.00	$228,000
5	FRP GRATING	SF	2,840	$25.00	$71,000	$10.00	$28,400		$ 35.00	$99,400
6	FEED PUMPS	EA	5	$19,000.00	$95,000	$6,000.00	$30,000		$ 25,000.00	$125,000
7	PUMP CONTROL	EA	5	$15,000.00	$75,000	$15,000.00	$75,000		$ 30,000.00	$150,000
8	SCADA CONTROL CABLE AND CONDUIT	LF	1,000	$5.00	$5,000	$5.00	$5,000		$ 10.00	$10,000
9	TEMPORARY FEED PUMPS	LS	1	$50,000.00	$50,000	$50,000.00	$50,000		$ 100,000.00	$100,000
10	ELECTRICAL	SF	5,000	$4.00	$20,000	$4.00	$20,000		$ 8.00	$40,000
11	ON-SITE GENERATION EQUIPMENT (ESTIMATE)	EA	1	$1,300,000.00	$1,300,000	$390,000.00	$390,000		$ 1,690,000.00	$1,690,000
12	BACK-UP GENERATOR (1500 kW)	EA	1	$200,000.00	$200,000	$200,000.00	$200,000		$ 400,000.00	$400,000
13	AUTOMATIC TRANSFER SWITCH (2000A)	EA	1	$27,000.00	$27,000	$27,000.00	$27,000		$ 54,000.00	$54,000
14	ELECTRICAL SERVICE UPGRADES	LS	1	$219,000.00	$219,000	$75,000.00	$75,000		$ 294,000.00	$294,000
15	**TANK PIPING**									
16	3" LINED STEEL PIPING	LF	1,200	$32.00	$38,400	$10.00	$12,000		$ 42.00	$50,400
17	3" LINED DUCTILE VALVES	EA	6	$725.00	$4,350	$500.00	$3,000		$ 1,225.00	$7,350
18	2" LINED STEEL PIPING	LF	1,200	$25.00	$30,000	$10.00	$12,000		$ 35.00	$42,000
19	2" LINED STEEL VALVES	EA	12	$425.00	$5,100	$500.00	$6,000		$ 925.00	$11,100
20	3" PVC TANK DRAIN	LF	1,200	$5.00	$6,000	$5.00	$6,000		$ 10.00	$12,000
21	3" PVC TANK DRAIN VALVES	EA	6	$260.00	$1,560	$100.00	$600		$ 360.00	$2,160
22	8" PVC TANK VENTS	EA	6	$600.00	$3,600	$300.00	$1,800		$ 900.00	$5,400
23	FLOW METERS	EA	6	$8,500.00	$51,000	$3,000.00	$18,000		$ 11,500.00	$69,000
24	LEVEL SENSORS	EA	6	$2,000.00	$12,000	$600.00	$3,600		$ 2,600.00	$15,600
25										
26	**FEED PIPING**									
27	3" FEED PIPING TO EXISTING FEED LINES (3 LINES x 400 FT)	LF	1,200	$32.00	$38,400	$10.00	$12,000		$ 42.00	$50,400
28										
29										
30	SUB-TOTAL				$2,436,070		$1,142,940			$3,579,010
31	5% SALE TAX				$121,804					$121,804
32	50% LABOR BURDEN						$571,470			$571,470
33										
34	SUB-TOTAL				$2,557,874		$1,714,410			$4,272,284
35	5% SUB BOND & INS (50% of PROJECT)									$106,807
36										
37	SUB-TOTAL									$4,379,091
38	10% SUB O/H (50% of PROJECT)									$218,955
39										
40	SUB-TOTAL									$4,598,045
41	10% SUB PROFIT (50% of PROJECT)									$229,902
42										
43	SUB-TOTAL									$4,827,947
44	5% PRIME BOND AND INS									$241,397
45										
46	SUB-TOTAL									$5,069,345
47	10% PRIME O/H									$506,934
48										
49	SUB-TOTAL									$5,576,279
50	10% PRIME PROFIT									$557,628
51										
52	SUB-TOTAL									$6,133,907
53	5% MOB / DEMOB									$306,695
54										
55	SUB-TOTAL									$6,440,602
56	25% CONTINGENCY									$1,610,151
57										
58	TOTAL (FEB 2007)									$8,050,753
59										
60	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2007)									$8,958,403

Project: DALECARLIA SODIUM HYPOCHLORITE | Sheet No. : ____ of ____

Location: DALECARLIA WTP

Project No.

Description: Convert Exixting Chlorine Building into Caustic and S. Acid Building
After Completion of the new hypochlorite facility (Full Caustic)

Design Status:
- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: **Figure 3.8** | Done By: ____ | Date: ____

Full caustic for pH adjustment. | Chkd By: ____ | Date: ____

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST	TOTAL UNIT COST	TOTAL COST
	BUILDING CONVERSION								
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000	$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	86	$270.00	$23,085	$130.00	$11,115	$400.00	$34,200
3	CONCRETE CONTAINMENT CURB	CY	10	$270.00	$2,700	$130.00	$1,300	$400.00	$4,000
4	HVAC IMPROVEMENTS--EXISTING	SF	5,000	$2.00	$10,000	$2.00	$10,000	$4.00	$20,000
5									
6	**CAUSTIC SODA**								
7	12' FRP CAUSTIC SODA TANKS - 11,800 GALLON	EA	9	$23,500.00	$211,500	$10,000.00	$90,000	$33,500.00	$301,500
8	LEVEL SENSORS	EA	9	$2,000.00	$18,000	$600.00	$5,400	$2,600.00	$23,400
9	8" PVC TANK VENTS	EA	9	$600.00	$5,400	$300.00	$2,700	$900.00	$8,100
10	3" PVC TANK DRAIN VALVES	EA	9	$260.00	$2,340	$100.00	$900	$360.00	$3,240
11	2" FILL LINES	LF	675	$22.00	$14,850	$8.00	$5,400	$30.00	$20,250
12	2" FILL VALVES	EA	5	$500.00	$2,250	$250.00	$1,125	$750.00	$3,375
13	FEED PUMPS	EA	6	$20,000.00	$110,000	$6,000.00	$33,000	$26,000.00	$143,000
14	FLOW METERS	EA	6	$8,500.00	$46,750	$3,000.00	$16,500	$11,500.00	$63,250
15	PUMP CONTROL	EA	3	$15,000.00	$45,000	$15,000.00	$45,000	$30,000.00	$90,000
16	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
17	3" LINED STEEL TANK PIPING	LF	1,890	$32.00	$60,480	$10.00	$18,900	$42.00	$79,380
18	3" LINED DUCTILE VALVES	EA	27	$725.00	$19,575	$500.00	$13,500	$1,225.00	$33,075
19	1" LINED STEEL FEED PIPING	LF	2,500	$25.00	$62,500	$5.00	$12,500	$30.00	$75,000
20	EXCAVATION BACKFILL	CY	450	$25.00	$11,250	$5.00	$2,250	$30.00	$13,500
21	CONCRETE PIPE TRENCH	LF	1,000	$125.00	$125,000	$50.00	$50,000	$175.00	$175,000
22									
23	**TEMPORARY CHEMICAL SYSTEM**								
24	SYSTEM SET-UP AND REMOVAL	LS	1	$0.00	$0	$55,000.00	$55,000	$55,000.00	$55,000
25	DAILY RENTAL FEE (ASSUMING 6 MO. CONSTRUCTION)	EA	180	$500.00	$90,000	$0	$0	$500.00	$90,000
26									
27									
28	SUB-TOTAL				$862,930		$476,840		$1,339,770
29	5% SALE TAX				$43,147				
30	50% LABOR BURDEN						$238,420		
31									
32	SUB-TOTAL				$906,077		$715,260		$1,621,337
33	5% SUB BOND & INS (50% OF PROJECT)								$40,533
34									
35	SUB-TOTAL								$1,661,870
36	10% SUB O/H (50% OF PROJECT)								$83,093
37									
38	SUB-TOTAL								$1,744,963
39	10% SUB PROFIT (50% OF PROJECT)								$87,248
40									
41	SUB-TOTAL								$1,832,212
42	5% PRIME BOND AND INS								$91,611
43									
44	SUB-TOTAL								$1,923,822
45	10% PRIME O/H								$192,382
46									
47	SUB-TOTAL								$2,116,204
48	10% PRIME PROFIT								$211,620
49									
50	SUB-TOTAL								$2,327,825
51	5% MOB / DEMOB								$116,391
52									
53	SUB-TOTAL								$2,444,216
54	25% CONTINGENCY								$611,054
55									
56	TOTAL (FEB 2007)								$3,055,270
57									
58	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)								$3,416,273

Project: DALECARLIA SODIUM HYPOCHLORITE Sheet No. : ______ of ______

Location: DALECARLIA WTP

Project No.

Description: Convert Exixting Chlorine Building into Caustic and S. Acid Building
After Completion of the new hypochlorite facility (Caustic Trim)

Design Status:

- [X] No Design Completed
- [ ] Preliminary Design
- [ ] Final Design
- [ ] Other:

Remarks: **Figure 3.8**

Lime and Caustic trim for pH adjustment.

Done By: ______ Date: ______

Chkd By: ______ Date: ______

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST	TOTAL UNIT COST	TOTAL COST
	BUILDING CONVERSION								
1	DEMO EXISTING BUILDING	LS	1	$0.00	$0	$100,000.00	$100,000	$100,000.00	$100,000
2	CONCRETE TANK PADS	CY	38	$270.00	$10,260	$130.00	$4,940	$400.00	$15,200
3	CONCRETE CONTAINMENT CURB	CY	10	$270.00	$2,700	$130.00	$1,300	$400.00	$4,000
4	HVAC IMPROVEMENTS--EXISTING	SF	5,000	$2.00	$10,000	$2.00	$10,000	$4.00	$20,000
5									
6	**CAUSTIC SODA**								
7	12' FRP CAUSTIC SODA TANKS - 11,800 GALLON	EA	4	$23,500.00	$94,000	$10,000.00	$40,000	$33,500.00	$134,000
8	LEVEL SENSORS	EA	4	$2,000.00	$8,000	$600.00	$2,400	$2,600.00	$10,400
9	8" PVC TANK VENTS	EA	4	$600.00	$2,400	$300.00	$1,200	$900.00	$3,600
10	3" PVC TANK DRAIN VALVES	EA	4	$260.00	$1,040	$100.00	$400	$360.00	$1,440
11	2" FILL LINES	LF	300	$22.00	$6,600	$8.00	$2,400	$30.00	$9,000
12	2" FILL VALVES	EA	2	$500.00	$1,000	$250.00	$500	$750.00	$1,500
13	FEED PUMPS	EA	3	$20,000.00	$60,000	$6,000.00	$18,000	$26,000.00	$78,000
14	FLOW METERS	EA	3	$8,500.00	$25,500	$3,000.00	$9,000	$11,500.00	$34,500
15	PUMP CONTROL	EA	3	$15,000.00	$45,000	$15,000.00	$45,000	$30,000.00	$90,000
16	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
17	3" LINED STEEL TANK PIPING	LF	840	$32.00	$26,880	$10.00	$8,400	$42.00	$35,280
18	3" LINED DUCTILE VALVES	EA	12	$725.00	$8,700	$500.00	$6,000	$1,225.00	$14,700
19	1" LINED STEEL FEED PIPING	LF	2,500	$25.00	$62,500	$5.00	$12,500	$30.00	$75,000
20	EXCAVATION BACKFILL	CY	450	$25.00	$11,250	$5.00	$2,250	$30.00	$13,500
21	CONCRETE PIPE TRENCH	LF	1,000	$125.00	$125,000	$50.00	$50,000	$175.00	$175,000
22									
23	**TEMPORARY CHEMICAL SYSTEM**								
24	SYSTEM SET-UP AND REMOVAL	LS	1	$0.00	$0	$55,000.00	$55,000	$55,000.00	$55,000
25	DAILY RENTAL FEE (ASSUMING 6 MO. CONSTRUCTION)	EA	180	$500.00	$90,000	$0	$0	$500.00	$90,000
26									
27									
28	SUB-TOTAL				$593,080		$371,540		$964,620
29	5% SALE TAX				$29,654				
30	50% LABOR BURDEN						$185,770		
31									
32	SUB-TOTAL				$622,734		$557,310		$1,180,044
33	5% SUB BOND & INS (50% OF PROJECT)								$29,501
34									
35	SUB-TOTAL								$1,209,545
36	10% SUB O/H (50% OF PROJECT)								$60,477
37									
38	SUB-TOTAL								$1,270,022
39	10% SUB PROFIT (50% OF PROJECT)								$63,501
40									
41	SUB-TOTAL								$1,333,523
42	5% PRIME BOND AND INS								$66,676
43									
44	SUB-TOTAL								$1,400,200
45	10% PRIME O/H								$140,020
46									
47	SUB-TOTAL								$1,540,220
48	10% PRIME PROFIT								$154,022
49									
50	SUB-TOTAL								$1,694,242
51	5% MOB / DEMOB								$84,712
52									
53	SUB-TOTAL								$1,778,954
54	25% CONTINGENCY								$444,738
55									
56	TOTAL (FEB 2007)								$2,223,692
57									
58	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)								$2,486,438

Project: Sodium Hypochlorite Study — Sheet No. : ____ of ____

Location: McMillan WTP

Project No.

Description: Convert Existing Chlorine Storage Room into Caustic and S. Acid Room

Design Status: [X] No Design Completed [ ] Preliminary Design [ ] Final Design [ ] Other:

Remarks: Figure 3.7 — Done By: ____ Date: ____

Sulfuric Acid and Caustic Soda are used for final pH adjustment — Chkd By: ____ Date: ____

Target storage of 21,000 gal Caustic and 3,000 gal S. Acid

ITEM NO.	DESCRIPTION	UNIT	QUANTITY	MATERIAL COST UNIT	TOTAL MATERIAL COST	LABOR COST UNIT	TOTAL LABOR COST	TOTAL UNIT COST	TOTAL COST
	CHLORINE FACILITY AREA CONVERSION								
1	DEMO EXISTING (REMOVE Cl2 MANIFOLDS, ETC.)	LS	1	$0.00	$0	$100,000.00	$100,000	$100,000.00	$100,000
2	CONCRETE CONTAINMENT CURB	CY	8	$270.00	$2,160	$130.00	$1,040	$400.00	$3,200
3									
4	**CAUSTIC SODA**								
5	7' FRP CAUSTIC SODA TANKS - 3,000 GALLON	EA	7	$10,000.00	$70,000	$4,000.00	$28,000	$14,000.00	$98,000
6	LEVEL SENSORS	EA	7	$2,000.00	$14,000	$600.00	$4,200	$2,600.00	$18,200
7	8" PVC TANK VENTS	EA	7	$600.00	$4,200	$300.00	$2,100	$900.00	$6,300
8	3" PVC TANK DRAIN VALVES	EA	7	$260.00	$1,820	$100.00	$700	$360.00	$2,520
9	2" FILL LINES	LF	175	$22.00	$3,850	$22.00	$3,850	$44.00	$7,700
10	2" FILL VALVES	EA	2	$500.00	$1,000	$250.00	$500	$750.00	$1,500
11	FEED PUMPS	EA	3	$20,000.00	$60,000	$6,000.00	$18,000	$26,000.00	$78,000
12	FLOW METERS	EA	3	$8,500.00	$25,500	$3,000.00	$9,000	$11,500.00	$34,500
13	PUMP CONTROL	EA	3	$15,000.00	$45,000	$15,000.00	$45,000	$30,000.00	$90,000
14	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
15	3" LINED STEEL TANK PIPING	LF	875	$32.00	$28,000	$10.00	$8,750	$42.00	$36,750
16	3" LINED DUCTILE VALVES	EA	21	$725.00	$15,225	$500.00	$10,500	$1,225.00	$25,725
17	1" LINED STEEL FEED PIPING	LF	1,000	$25.00	$25,000	$5.00	$5,000	$30.00	$30,000
18									
19	**SULFURIC ACID**								
20	7' STEEL ACID TANKS - 3,000 GALLON	EA	1	$14,000.00	$14,000	$10,000.00	$10,000	$24,000.00	$24,000
21	LEVEL SENSORS	EA	1	$2,000.00	$2,000	$600.00	$600	$2,600.00	$2,600
22	8" PVC TANK VENTS	EA	1	$600.00	$600	$300.00	$300	$900.00	$900
23	3" PVC TANK DRAIN VALVES	EA	1	$260.00	$260	$100.00	$100	$360.00	$360
24	2" FILL LINES	LF	50	$22.00	$1,100	$22.00	$1,100	$44.00	$2,200
25	2" FILL VALVES	EA	1	$500.00	$500	$250.00	$250	$750.00	$750
26	FEED PUMPS	EA	1	$20,000.00	$20,000	$6,000.00	$6,000	$26,000.00	$26,000
27	FLOW METERS	EA	1	$8,500.00	$8,500	$3,000.00	$3,000	$11,500.00	$11,500
28	PUMP CONTROL	EA	1	$15,000.00	$15,000	$15,000.00	$15,000	$30,000.00	$30,000
29	SCADA CONTROL CABLE AND CONDUIT	LF	450	$5.00	$2,250	$5.00	$2,250	$10.00	$4,500
30	3" LINED STEEL TANK PIPING	LF	150	$32.00	$4,800	$10.00	$1,500	$42.00	$6,300
31	3" LINED DUCTILE VALVES	EA	2	$725.00	$1,450	$500.00	$1,000	$1,225.00	$2,450
32	1/2" LINED STEEL FEED PIPING	LF	1,000	$20.00	$20,000	$5.00	$5,000	$25.00	$25,000
33	2" PVC CONDUIT FOR FEED PIPING	LF	1,000	$2.00	$2,000	$1.00	$1,000	$3.00	$3,000
34									
35	**TEMPORARY CHEMICAL SYSTEM**								
36	SYSTEM SET-UP AND REMOVAL	LS	1	$0.00	$0	$77,000	$77,000	$77,000.00	$77,000
37	DAILY RENTAL FEE (ASSUMING 6 MO. CONSTRUCTION)	EA	180	$1,000.00	$180,000	$0	$0	$1,000.00	$180,000
38									
39									
40	SUB-TOTAL				$570,465		$362,990		$933,455
41	5% SALE TAX				$28,523				
42	50% LABOR BURDEN						$181,495		
43									
44	SUB-TOTAL				$598,988		$544,485		$1,143,473
45	5% SUB BOND & INS (50% OF PROJECT)								$28,587
46									
47	SUB-TOTAL								$1,172,060
48	10% SUB O/H (50% OF PROJECT)								$58,603
49									
50	SUB-TOTAL								$1,230,663
51	10% SUB PROFIT (50% OF PROJECT)								$61,533
52									
53	SUB-TOTAL								$1,292,196
54	5% PRIME BOND AND INS								$64,610
55									
56	SUB-TOTAL								$1,356,806
57	10% PRIME O/H								$135,681
58									
59	SUB-TOTAL								$1,492,487
60	10% PRIME PROFIT								$149,249
61									
62	SUB-TOTAL								$1,641,735
63	5% MOB / DEMOB								$82,087
64									
65	SUB-TOTAL								$1,723,822
66	25% CONTINGENCY								$430,956
67									
68	TOTAL								$2,154,778
69									
70	TOTAL ESCALATED TO MID-CONSTRUCTION (JAN 2009)								$2,409,380

Appendix H. Socioeconomic Memorandum

CENAB-WA-EN 9 MARCH 2007

MEMORANDUM FOR RECORD

SUBJECT: Socioeconomic Analysis for the vicinity of the Dalecarlia WTP and the McMillan WTP

1. References: LandView® 6, United States Census Bureau (2003); DC Atlas, District of Columbia government (2007); Montgomery County GIS, Montgomery County (MD) government (2007); Final Environmental Impact Statement for a Proposed Water Treatment Residuals Management Process for the Washington Aqueduct, Washington Aqueduct (2003).

2. As part of the Environmental Assessment for System Improvements of the Dalecarlia WTP and McMillan WTP for Disinfection and pH Control, an assessment of existing socioeconomic conditions and potential effects on these conditions from the proposed action is necessary. Four sources were used to accumulated relevant socioeconomic information: the on-line DC Atlas (District of Columbia Geographic Information System); the on-line Montgomery County Geographic Information System portal; LandView® 6 (United States Census Bureau); and the 2003 Final Environmental Impact Statement for a Proposed Water Treatment Residuals Management Process for the Washington Aqueduct (Washington Aqueduct). The sources of information used in the Washington Aqueduct document (Residuals EIS) included LandView® 6 and other sources.

3. Table 1 provides a summary of demographic information for the region, the District of Columbia, Montgomery County (MD), Fairfax County (VA), and the areas within one mile of the Dalecarlia WTP (38.940189 N, 77.115456 W) and the McMillan WTP (38.925 N, 77.013611 W). Lists of public places within one mile radii of the project areas are shown in Tables 2 and 3 for the Dalecarlia WTP and McMillan WTP, respectively.

4. Environmental Justice: As shown in Table 1, Minority and low-income populations, as defined by Executive Order 12898 and the Council of Environmental Quality, are present in the vicinity of the McMillan WTP, but not in the vicinity of the Dalecarlia WTP.

a. According to 2000 Census information in LandView® 6, 79.9 percent of the individuals living within one mile of the McMillan WTP are Black or African American.

b. In addition, 23.7 percent of individuals live in poverty status in the same area around the McMillan WTP – 6.8 percent more than the District of Columbia rate and 16.1 percent more than the regional rate.

5. As shown in Table 2, there is a variety of schools, parks and other recreation areas, and a hospital within the proximity of the Dalecarlia WTP. As shown in Table 3, there is an even wider variety of schools, universities and colleges, parks and other recreation areas, and hospitals within the proximity of the McMillan WTP.

6. Protection of Children: Executive Order 13045 seeks to protect children from disproportionately incurring environmental health or safety risks that might arise as a result of government policies, programs, activities, and standards. Children are present near the project areas and along potential transportation routes as residents of the areas and as visitors in schools, parks, and recreation centers.

a. The Washington Aqueduct has taken, and will continue to take, precautionary measures to reduce risk to children during construction and operation of facilities by providing fencing, security, and other means by which child interaction onsite can be prevented.

b. Through contract stipulations Washington Aqueduct requires appropriately safe vehicles and driver certification for deliveries of materials necessary for operation and maintenance of Washington Aqueduct facilities.

7. Through proper engineering and management controls at the Dalecarlia WTP and the McMillan WTP, the risk of a potential uncontrolled release of liquid chlorine has been minimized. However, an improbable risk does exist, particularly with consideration of the potential for an incident associated with liquid chlorine delivery vehicles on or off-site.

a. Adoption of the proposed action is advantageous to selection of the “no-action” alternative in considering environmental justice due to the presence of minority and economically disadvantaged populations within the community around the McMillan WTP because it would eliminate the existing potential, although improbable, risk.

b. There is not a significant presence of minority or economically disadvantaged populations within the community around the Dalecarlia WTP, but adoption of the proposed action would also be advantageous in eliminating the existing potential, although improbable, risk to the adjacent community.

c. Adoption of the proposed action would be advantageous under the same rationale, in the protection of children and in considering the proximity of area schools, hospitals and recreation facilities near both the McMillan WTP and the Dalecarlia WTP. However, selection of the “no-action” alternative would not result in a significant impact because the existing engineering and management controls minimize the potential risk and make occurrence of an uncontrolled release of chlorine improbable.

d. Although the required number of deliveries of aqueous sodium hypochlorite is greater than the required number of deliveries of liquid chlorine, it would still be advantageous, considering environmental justice and protection of children, to eliminate liquid chlorine deliveries due to the higher possibility of catastrophic consequences in the event of an uncontrolled release when compared to delivering aqueous sodium hypochlorite.

8. Economic Development: The federal spending in the region of influence in 2002 was $87.5 billion, including $37.3 billion in contracts. In the central jurisdictions of the region of influence, the cost of construction for office space, education and medical space, and other commercial spaces in 2002 was approximately $1.65 billion in 2002. The planned budget for the proposed action is $13 million. Compared to the typical amount of federal spending and the cost of new construction annually in the region of influence, the proposed project budget would be a marginally additive. Selection of the proposed action for implementation, or selection of the status quo "no-action" alternative would not have a significant impact on the economic development.

9. In conclusion, there are no anticipated significant impacts from the various alternatives considered as the proposed action or the "no-action" alternatives to existing socioeconomic characteristics in the vicinity of the McMillan WTP or Dalecarlia WTP. However, selection of the proposed action would be advantageous to the communities surrounding the two proposed project areas because it would eliminate the existing potential, although improbable, risk of an uncontrolled release of liquid chlorine.

MICHAEL C. PETERSON
Environmental Engineer

Table 1 Summary of select 2000 United States Census demographic Data for the District of Columbia Region of Influence, the District of Columbia, Montgomery County in the State of Maryland, Fairfax County in the Commonwealth of Virginia, and for the immediate areas in the proximity of the Dalecarlia Water Treatment Plant and the McMillan Water Treatment Plant. (source: LandView® 6)

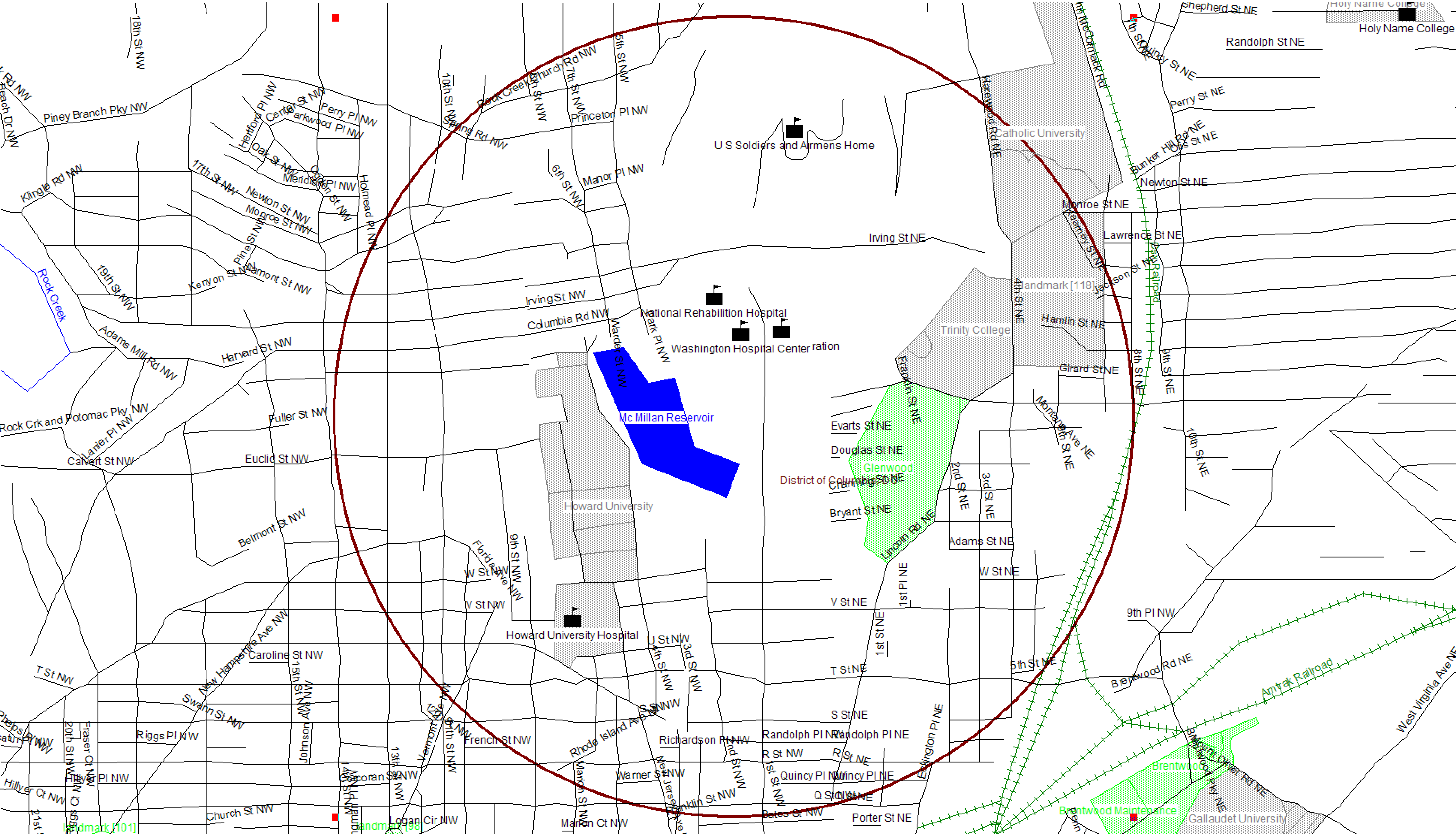
Demographics Category	Region of Influence	District of Columbia	Montgomery County, MD	Fairfax County, VA	Estimated 1-mile Radius, Dalecarlia WTP	Estimated 1-mile Radius, McMillan WTP
Total Population 1990	3,923,600	537,218	989,655	818,584	NA	NA
Total Population 2000	4,450,300	572,059	873,341	969,749	7,548	45,279
Persons per Square Mile	1,474	9,317	1,762	2,455	3,536	13,808
Projected Growth 2015	5,392,900	588,000	975,000	1,155,600	NA	NA
Percent Change 2000-2015	21.18	2.79	11.64	19.16	NA	NA
Median Age (Years)	34.90	34.60	36.80	37.00	NA	NA
Average Household Size	2.59	2.16	2.66	2.74	NA	NA
Average Family Size	NA	3.07	3.19	3.20	NA	NA
Veterans (% Civilians)	12.00	9.80	9.90	13.50	9.2	13.2
White Population	57.00	30.78	64.78	69.91	91.5	9.0
Black or African American Population	28.20	60.00	15.10	8.60	2.4	79.9
American Indian & Alaska Native Population	0.30	0.30	0.29	0.26	0.2	0.4
Asian, Hawaiian, and other Pacific Islander Population	7.60	2.70	11.30	13.00	3.6	1.0
Some other race Population	4.00	3.84	5.00	4.54	0.9	6.9
Two or more races Population	3.00	2.35	3.45	3.65	1.5	2.7
Hispanic Origin Population	9.70	7.90	11.50	11.00	5.2	11.5
Poverty Rate (%)	7.60	16.90	4.20	3.50	2.31	23.7

Table 2 List of various schools, parks, recreation areas or facilities, and hospitals in the vicinity of the Dalecarlia WTP project area (sources: LandView® 6, the DC Atlas, Montgomery County GIS, and the Residuals EIS).

Name	Category
Brookmont Neighborhood Park	Recreation
Cabin John Brookmont Children's Center	School
Capital Crescent Trail	Recreation
C&O Canal National Historic Park	National Park
Fort Marcy Park	Recreation
George Washington Memorial Parkway	National Park
Sangamore Local Park	Recreation
Sibley Memorial Hospital	Hospital
Spring Valley Park	Recreation
Washington Waldorf School	School
Westmoreland Children's Center Circle Campus	School
Westmoreland Hills Local Park	Recreation

Table 3 List of various schools, parks, recreation areas or facilities, and hospitals in the vicinity of the McMillan WTP project area (sources: LandView® 6 and the DC Atlas).

Name	Category
Banneker Community Center	Recreation
Benjamin Banneker High School	School
Bruce-Monroe Elementary School	School
Bruce-Monroe Recreation Center	Recreation
Cardoza Senior High School	School
Carlos Rosario International PCS	School
Catholic University	University
Children’s Hospital National Medical Center	Hospital
Children’s Studio School, PCS	School
City Lights PCS	School
Cleveland Elementary School	School
Cooke, H.D. Elementary School	School
DC Bilingual PCS	School
Dominican House of Studies	College
Eckington Recreation Center	Recreation
Edgewood Playground	Recreation
Edgewood Recreation Center	Recreation
Emery Elementary School	School
Gage-Eckington Elementary School	School
Garfield Terrace Senior Citizens Center	Recreation
General Scott Statue	Recreation
Howard University	University
Howard Playground	Recreation
Howard University Hospital	Hospital
John F. Kennedy Recreation Center	Recreation
K. C. Lewis Recreation Center	Recreation
Langley Recreation Center	Recreation
LeDroit Senior Center	Recreation
Lieutenant General Winfield B. Scott Statue	Recreation
McKinley Technology High School	School
Meridian PCS	School
Meyer Elementary School	School
Noyes Elementary School	School
Parkview Elementary School	School
Parkview Playground	Recreation
Parkview Recreation Center	Recreation
Raymond Recreation Center	Recreation
Saint Dominic Statue	Recreation
St Paul’s College	College
Seventh Street Park	Recreation
Shaed Elementary School	School
The National Rehabilitation Hospital	Hospital
Tri-Community PCS	School
Trinity College	College
Tubman Elementary School	School
Veterans Administration Hospital	Hospital
Washington Hospital Center	Hospital
William E. Doar Jr. PCS for the Performing Arts	School


Holy Name College
Shepherd St NE
Randolph St NE
Quincy St NE
Perry St NE
Bunker Hill Rd NE
Otis St NE
Newton St NE
Monroe St NE
Lawrence St NE
Jackson St NE
Hamlin St NE
Girard St NE
Catholic University
Harewood Rd NE
Landmark [118]
Trinity College
Franklin St NE
Irving St NE
U S Soldiers and Airmens Home
Princeton Pl NW
Rock Creek Church Rd NW
Spring Rd NW
Manor Pl NW
National Rehabilitation Hospital
Washington Hospital Center
Mc Millan Reservoir
Irving St NW
Columbia Rd NW
Harvard St NW
Fuller St NW
Euclid St NW
Belmont St NW
Howard University
Howard University Hospital
Evarts St NE
Douglas St NE
Channing St NE
Bryant St NE
Adams St NE
W St NE
V St NE
T St NE
S St NE
Glenwood
Lincoln Rd NE
District of Columbia
1st Pl NE
1st St NE
2nd St NE
3rd St NE
9th Pl NW
Brentwood Rd NE
Amtrak Railroad
West Virginia Ave NE
Mount Olivet Rd NE
Brentwood
Brentwood Maintenance
Gallaudet University
Porter St NE
Quincy Pl NE
Randolph Pl NE
R St NW
Eckington Pl NE
Piney Branch Pky NW
Rock Creek
Klingle Rd NW
Kenyon St NW
Adams Mill Rd NW
Rock Crk and Potomac Pky NW
Calvert St NW
Lanier Pl NW
Newton St NW
Monroe St NW
Perry Pl NW
Parkwood Pl NW
Oak St NW
Holmead Pl NW
Park Pl NW
Warder St NW
Georgia Ave NW
Florida Ave NW
W St NW
V St NW
U St NW
New Hampshire Ave NW
Caroline St NW
T St NW
Swann St NW
Riggs Pl NW
Vermont Ave NW
French St NW
Rhode Island Ave NW
S St NW
Richardson Pl NW
Warner St NW
Marion St NW
Marion Ct NW
Logan Cir NW
Corcoran St NW
Church St NW
Hillyer Pl NW
Landmark [101]
14th St NW
13th St NW
10th St NW
9th St NW
7th St NW
6th St NW
5th St NW
4th St NW
3rd St NW
19th St NW
18th St NW
17th St NW
15th St NW
Quincy Pl NW
Q St NW
Bates St NW
New Jersey Ave NW
8th St NE
4th St NE
9th St NE
10th St NE
5th St NE

LandView 6 - Census 2000 Profile of General Demographic Characteristics DP-1 (100%)

Summary of Census Block Groups # records summarized: 34

Total population: 45,279 Total Housing Units: 19,479 Persons per sq. mi: 13,807.5

Population estimate for radius: 1 miles (38.925, -77.013611)

	Number	PCT
SEX AND AGE		
Male	21,737	48.0
Female	23,542	52.0
Under 5 years	2,622	5.8
Age 5 to 9 years	2,983	6.6
Age 10 to 14 years	2,705	6.0
Age 15 to 19 years	3,962	8.8
Age 20 to 24 years	5,209	11.5
Age 25 to 34 years	6,882	15.2
Age 35 to 44 years	6,865	15.2
Age 45 to 54 years	5,640	12.5
Age 55 to 59 years	1,868	4.1
Age 60 to 64 years	1,573	3.5
Age 65 to 74 years	2,468	5.5
Age 75 to 84 years	1,859	4.1
Age 85 years and over	643	1.4
Median age	(X)	(X)
Age 18 years and over	35,394	78.2
Male	16,700	36.9
Female	18,694	41.3
Age 21 years and over	31,665	69.9
Age 62 years and over	5,867	13.0
Age 65 years and over	4,970	11.0
Male	1,795	4.0
Female	3,175	7.0
RACE		
One race	44,035	97.3
White	4,067	9.0
Black or African American	36,198	79.9
American Indian and Alaska Native	175	0.4
Asian	473	1.0
Asian Indian *	(X)	(X)
Chinese *	(X)	(X)
Filipino *	(X)	(X)
Japanese *	(X)	(X)
Korean *	(X)	(X)
Vietnamese *	(X)	(X)
Other Asian * 1	(X)	(X)
Native Hawaiian and Other Pacific Is.	6	0.0
Native Hawaiian *	(X)	(X)
Guamanian or Chamorro *	(X)	(X)
Samoan *	(X)	(X)
Other Pacific Islander * 2	(X)	(X)
Some other race	3,116	6.9
Two or more races	1,244	2.7
RACE alone or combined with one or more other races 3		
White	4,615	10.2
Black or African American	37,076	81.9
American Indian and Alaska Native	444	1.0
Asian	639	1.4
Native Hawaiian and Other Pacific Is.	51	0.1
Some other race	3,835	8.5

	Number	PCT
HISPANIC OR LATINO AND RACE		
Hispanic or Latino (of any race)	5,189	11.5
Mexican *	(X)	(X)
Puerto Rican *	(X)	(X)
Cuban *	(X)	(X)
Other Hispanic or Latino *	(X)	(X)
Not Hispanic or Latino	40,090	88.5
White alone	2,806	6.2
RELATIONSHIP		
In households	40,798	90.1
Householder	16,293	36.0
Spouse	3,030	6.7
Child	10,704	23.6
Own child under 18 years	6,947	15.3
Other relatives	5,694	12.6
Under 18 years	2,430	5.4
Nonrelatives	5,077	11.2
Unmarried partner *	(X)	(X)
In group quarters	4,481	9.9
Institutionalized population	219	0.5
Noninstitutionalized population	4,262	9.4
HOUSEHOLDS BY TYPE		
Total households	16,293	100
Family households (families)	8,215	50.4
With own children under 18 yrs	3,687	22.6
Married couple family	3,030	18.6
With own children under 18 yrs	1,328	8.2
Female householder, no husband present	4,188	25.7
With own children under 18 yrs	2,037	12.5
Nonfamily households	8,078	49.6
Householder living alone	6,152	37.8
Householder 65 years and over	1,775	10.9
Households with persons under 18 years	4,953	30.4
Households with persons 65 yrs. and over	4,022	24.7
Average household size	(X)	(X)
Average family size	(X)	(X)
HOUSING OCCUPANCY		
Total housing units	19,479	100
Occupied housing units	16,293	83.6
Vacant housing units	3,186	16.4
For seasonal/recreational/occasional use	47	0.2
Homeowner vacancy rate (percent)	(X)	(X)
Rental vacancy rate (percent)	(X)	(X)
HOUSING TENURE		
Occupied housing units	16,293	100
Owner-occupied	6,393	39.2
Renter-occupied	9,900	60.8
Average household size, owner occupied units	(X)	(X)
Average household size, renter occupied units	(X)	(X)
LAND AREA		
Square Miles		3.28
Square Kilometers		8.49

(X) - Not applicable, or statistic not calculated by summarize function * These fields not available at Block Group level

1 Other Asian alone, or two or more Asian categories.

2 Other Pacific Islander alone, or two or more Native hawaiian and Other Pacific Islander categories.

3 In combination with one or more races listed. The following six numbers may add to more than the total population and the six percentages may add to more than 100 percent because individuals may report more than one race.

LandView 6 - Census 2000 Profile of Selected Social Characteristics (DP-2)

Summary of Census Block Groups # records summarized 34

Population estimate for radius: 1 miles (38.925, -77.013611)

SCHOOL ENROLLMENT	Number	PCT
Population 3 years and over enrolled in school	14,780	100.0
Nursery school, preschool	831	5.6
Kindergarten	728	4.9
Elementary school (grades 1-8)	4,576	31.0
High school (grades 9-12)	2,432	16.5
College or graduate school	6,213	42.0
EDUCATIONAL ATTAINMENT		
Population 25 years and over	27,682	100.0
Less than 9th grade	3,685	13.3
9th to 12th grade, no diploma	6,171	22.3
High school graduate (incl. equiv.)	6,523	23.6
Some college, no degree	5,082	18.4
Associate degree	778	2.8
Bachelor's degree	3,027	10.9
Graduate or professional degree	2,416	8.7
Percent high school graduate or higher	64.4	(X)
Percent bachleor's degree or higher	19.7	(X)
MARITAL STATUS		
Population 15 years and over	36,650	100.0
Never married	19,693	53.7
Now married, except separated	8,065	22.0
Separated	1,791	4.9
Widowed	3,202	8.7
Female	2,559	7.0
Divorced	3,899	10.6
Female	1,973	5.4
GRANDPARENTS AS CAREGIVERS		
Grandparent living in household with one or more own grandchildren under 18 years *	(X)	(X)
Grandparent responsible for grandchildren *	(X)	(X)
VETERAN STATUS		
Civilian population 18 years and over	35,099	100.0
Civilian veterans	3,236	9.2
DISABILITY STATUS OF THE CIVILIAN NONINSTITUTIONALIZED POPULATION		
Population 5 to 20 years	10,641	100.0
With a disability	1,091	10.3
Population 21 to 64 years	26,325	100.0
With a disability	7,536	28.6
Percent employed	(X)	(X)
No disability	18,789	71.4
Percent employed	(X)	(X)
Population 65 years and over	4,971	100.0
With a disability	2,789	56.1
RESIDENCE IN 1995		
Population 5 years and over	42,217	100.0
Same house in 1995	20,901	49.5
Different house in the U.S./Puerto Rico in 1995	18,814	44.6
Same county/municipio (PR)	10,669	25.3
Different county/municipio (PR)	8,145	19.3
Same state/Outside PR in 1995	0	0.0
Different state/United States (PR)	8,145	19.3
Elsewhere/Elsewhere (PR) in 1995	2,502	5.9

NATIVITY AND PLACE OF BIRTH	Number	PCT
Total population	44,818	100.0
Native	38,391	85.7
Born in United States/Puerto Rico	38,051	84.9
State of residence/Born in the U.S. (PR)	19,403	43.3
Different state/Born in U.S. Island Areas (PR)	18,648	41.6
Born outside U.S./Born abroad of Amer...(PR)	340	0.8
Foreign born	6,427	14.3
Entered 1990 to March 2000	3,171	7.1
Naturalized citizen	1,990	4.4
Not a citizen	4,437	9.9
REGION OF BIRTH OF FOREIGN BORN		
Total population (excl. born at sea)	(X)	(X)
Europe *	(X)	(X)
Asia *	(X)	(X)
Africa *	(X)	(X)
Oceania *	(X)	(X)
Latin America *	(X)	(X)
Northern America *	(X)	(X)
LANGUAGE SPOKEN AT HOME		
Population 5 years and over	42,217	100.0
English only	34,371	81.4
Language other than English	7,846	18.6
Speak English less than "very well"	3,810	9.0
Spanish	5,570	13.2
Speak English less than "very well"	3,030	7.2
Other Indo-European languages	905	2.1
Speak English less than "very well"	281	0.7
Asian and Pacific Island languages	241	0.6
Speak English less than "very well"	136	0.3
ANCESTRY (single or multiple)		
Total population *	(X)	(X)
*Total ancestries reported **	(X)	(X)
Arab *	(X)	(X)
Czech * 1	(X)	(X)
Danish *	(X)	(X)
Dutch *	(X)	(X)
English *	(X)	(X)
French (except Basque) * 1	(X)	(X)
French Canadian * 1	(X)	(X)
German *	(X)	(X)
Greek *	(X)	(X)
Hungarian *	(X)	(X)
Irish * 1	(X)	(X)
Italian *	(X)	(X)
Lithuanian *	(X)	(X)
Norwegian *	(X)	(X)
Polish *	(X)	(X)
Portuguese *	(X)	(X)
Russian *	(X)	(X)
Scotch-Irish *	(X)	(X)
Scottish *	(X)	(X)
Slovak *	(X)	(X)
Subsaharan African *	(X)	(X)
Swedish *	(X)	(X)
Swiss *	(X)	(X)
Ukrainian *	(X)	(X)
United States or American *	(X)	(X)
Welsh *	(X)	(X)
West Indian (excluding Hispanic groups) *	(X)	(X)
Other ancestries *	(X)	(X)

(X) - Not applicable, or statistic not calculated by summarize function   * These fields not available at Block Group level

1 The data represent a combination of two ancestries shown separately in Summary File 3. Czech includes Czechoslovakian. French includes Alsatian. French Canadian includes Acadian/Cajun. Irish includes Celtic.

LandView 6 - Census 2000 Profile of Selected Economic Characteristics (DP-3)

Summary of Census Block Groups | # records summarized: 34

Population estimate for radius: 1 miles (38.925, -77.013611)

EMPLOYMENT STATUS	Number	PCT
Population 16 years and over	36,167	100.0
In labor force	20,844	57.6
Civilian labor force	20,777	57.4
Employed	18,077	50.0
Unemployed	2,700	7.5
Percent of civilian labor force	13.0	(X)
Armed Forces	67	0.2
Not in labor force	15,323	42.4
Females 16 years and over	19,197	100.0
In labor force	10,314	53.7
Civilian labor force	10,294	53.6
Employed	9,182	47.8
Own children under 6 years	2,864	100.0
All parents in family in labor force	1,657	57.9
COMMUTING TO WORK		
Workers 16 years and over	17,646	100.0
Car, truck, or van -- drove alone	6,072	34.4
Car, truck, or van -- carpooled	2,041	11.6
Public transportation (including taxicab)	6,837	38.7
Walked	1,908	10.8
Other means	288	1.6
Worked at home	500	2.8
Mean travel time to work (minutes) [1]	(X)	(X)
Employed civilian population 16 years and over	18,077	100.0
OCCUPATION		
Management, professional, and related occupations	6,081	33.6
Service occupations	3,980	22.0
Sales and office occupations	5,411	29.9
Farming, fishing, & forestry occupations	13	0.1
Construction, extraction, and maintenance occupations	1,312	7.3
Production, transportation, and material moving occupations	1,280	7.1
INDUSTRY		
Agriculture, forestry, fishing, hunting, and mining	13	0.1
Construction	1,136	6.3
Manufacturing	372	2.1
Wholesale trade	246	1.4
Retail trade	1,650	9.1
Transportation and warehousing, and utilitites	825	4.6
Information	826	4.6
Finance, insurance, real estate, and rental and leasing	882	4.9
Professional, scientific, management, administrative, and waste management services	2,486	13.8
Educational, health, and social services	4,216	23.3
Arts, entertainment, recreation, accomodation, and food services	1,812	10.0
Other services (except public administration)	1,557	8.6
Public administration	2,056	11.4
CLASS OF WORKER		
Private wage and salary workers	13,101	72.5
Government workers	4,220	23.3
Self-employed workers in own not incorporated business	713	3.9
Unpaid family workers	43	0.2

INCOME IN 1999	Number	PCT
Households	16,368	100.0
Less than $10,000	3,547	21.7
$10,000 to $14,999	1,182	7.2
$15,000 to $24,999	2,462	15.0
$25,000 to $34,999	1,990	12.2
$35,000 to $49,999	2,499	15.3
$50,000 to $74,999	2,319	14.2
$75,000 to $99,999	1,100	6.7
$100,000 to $149,999	779	4.8
$150,000 to $199,999	314	1.9
$200,000 or more	176	1.1
Median household income (dollars)	(X)	(X)
With earnings	12,043	73.6
Mean earnings (dollars) [1]	(X)	(X)
With Social Security income	4,103	25.1
Mean Social Security income (dollars) [1]	(X)	(X)
With Supplemental Security Income	1,342	8.2
Mean Supplemental Security income (dollars) [1]	(X)	(X)
With public assistance income	1,396	8.5
Mean public assistance income (dollars) [1]	(X)	(X)
With retirement income	2,972	18.2
Mean retirement income (dollars) [1]	(X)	(X)
Families	8,377	100.0
Less than $10,000	1,449	17.3
$10,000 to $14,999	514	6.1
$15,000 to $24,999	1,321	15.8
$25,000 to $34,999	1,041	12.4
$35,000 to $49,999	1,553	18.5
$50,000 to $74,999	1,212	14.5
$75,000 to $99,999	645	7.7
$100,000 to $149,999	390	4.7
$150,000 to $199,999	148	1.8
$200,000 or more	104	1.2
Median family income (dollars)	(X)	(X)
Per capita income (dollars) [1]	(X)	(X)
Median earnings (dollars):		
Male full-time, year-round workers *	(X)	(X)
Female full-time, year-round workers *	(X)	(X)

Subject	Number below poverty level	Percent below poverty level
POVERTY STATUS IN 1999		
Families	1,906	22.8
With related children under 18 years	1,373	(X)
With related children under 5 years	676	(X)
Families with female householder, no husband present	1,356	(X)
With related children under 18 years	1,125	(X)
With related children under 5 years	558	(X)
Individuals	10,715	(X)
18 years and over	7,521	(X)
65 years and over	1,242	(X)
Related children under 18 years *	(X)	(X)
Related children 5 to 17 years *	(X)	(X)
Unrelated individuals 15 years and over *	(X)	(X)

(X) - Not applicable, or statistic not calculated by summarize function

* These fields not available at Block Group level

1 If the denominator of a mean value or per capita value is less than 30, then that value is calculated using a rounded aggregate in the numerator.

LandView 6 - Census 2000 Profile of Selected Housing Characteristics (DP-4)

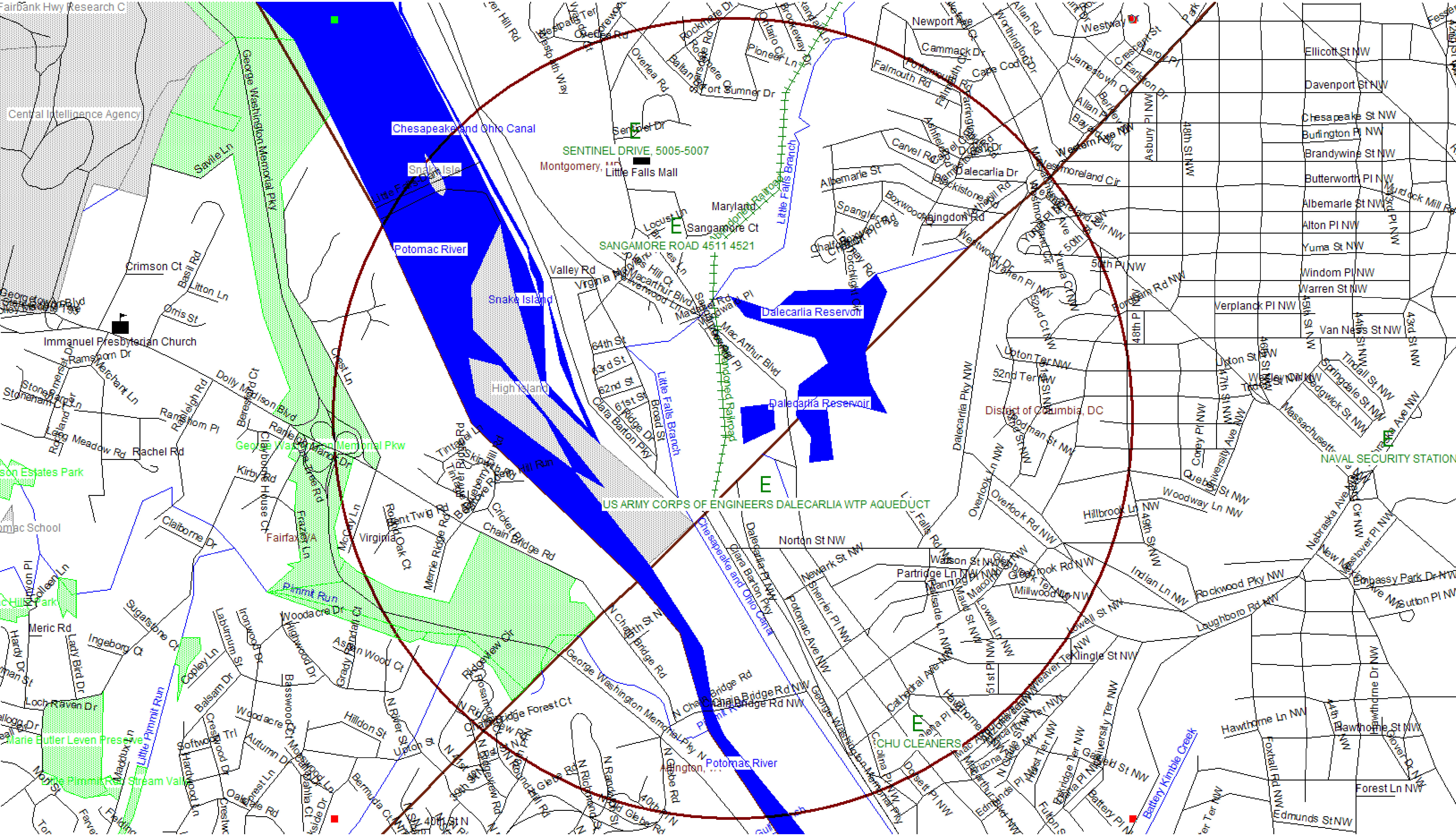
Summary of Census Block Groups # records summarized: 34

Population estimate for radius: 1 miles (38.925, -77.013611)

	Number	PCT
Total housing units	19,373	100.0
UNITS IN STRUCTURE		
1-unit, detached	782	4.0
1-unit, attached	8,738	45.1
2 units	747	3.9
3 or 4 units	1,367	7.1
5 to 9 units	1,450	7.5
10 to 19 units	2,196	11.3
20 or more units	4,079	21.1
Mobile home	7	0.0
Boat, RV, van, etc.	7	0.0
YEAR STRUCTURE BUILT		
1999 to March 2000	250	1.3
1995 to 1998	176	0.9
1990 to 1994	166	0.9
1980 to 1989	1,159	6.0
1970 to 1979	1,684	8.7
1960 to 1969	1,816	9.4
1940 to 1959	4,677	24.1
1939 or earlier	9,445	48.8
ROOMS		
1 room	1,263	6.5
2 rooms	1,984	10.2
3 rooms	4,048	20.9
4 rooms	2,885	14.9
5 rooms	1,808	9.3
6 rooms	3,036	15.7
7 rooms	1,747	9.0
8 rooms	1,209	6.2
9 rooms or more	1,393	7.2
Median (rooms)	(X)	(X)
Occupied housing units	16,217	100.0
YEAR HOUSEHOLDER MOVED INTO UNIT		
1999 to March 2000	3,738	23.1
1995 to 1998	4,312	26.6
1990 to 1994	2,213	13.6
1980 to 1989	2,171	13.4
1970 to 1979	1,509	9.3
1969 or earlier	2,274	14.0
VEHICLES AVAILABLE		
None	7,475	46.1
1	6,204	38.3
2	1,860	11.5
3 or more	678	4.2
HOUSE HEATING FUEL		
Utility gas	10,786	66.5
Bottled, tank, or LP gas	292	1.8
Electricity	3,604	22.2
Fuel oil, kerosene, etc.	1,300	8.0
Coal or coke	0	0.0
Wood	5	0.0
Solar energy	0	0.0
Other fuel	93	0.6
No fuel used	137	0.8
SELECTED CHARACTERISTICS		
Lacking complete plumbing facilities	203	1.3
Lacking complete kitchen facilities	173	1.1
No telephone service	702	4.3

OCCUPANTS PER ROOM	Number	PCT
Occupied housing units	16,217	100.0
1.00 or less	14,246	87.8
1.01 to 1.50	877	5.4
1.51 or more	1,094	6.7
Specified owner-occupied units	5,728	100.0
VALUE		
Less than $50,000	58	1.0
$50,000 to $99,999	1,361	23.8
$100,000 to $149,000	2,384	41.6
$150,000 to $199,999	1,154	20.1
$200,000 to $299,999	504	8.8
$300,000 to $499,999	206	3.6
$500,000 to $999,999	52	0.9
$1,000,000 or more	9	0.2
Median (dollars)	(X)	(X)
MORTGAGE STATUS AND SELECTED MONTHLY OWNER COSTS		
With a mortgage	4,267	74.5
Less than $300	23	0.4
$300 to $499	200	3.5
$500 to $699	425	7.4
$700 to $999	1,067	18.6
$1,000 to $1,499	1,762	30.8
$1,500 to $1,999	488	8.5
$2,000 or more	302	5.3
Median (dollars)	(X)	(X)
Not mortgaged	1,461	25.5
Median (dollars)	(X)	(X)
SELECTED MONTHLY OWNER COSTS AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	1,743	30.4
15.0 to 19.9 percent	670	11.7
20.0 to 24.9 percent	746	13.0
25.0 to 29.9 percent	532	9.3
30.0 to 34.9 percent	367	6.4
35.0 percent or more	1,549	27.0
Not computed	121	2.1
Specified renter-occupied units	9,809	100.0
GROSS RENT		
Less than $200	1,434	14.6
$200 to $299	705	7.2
$300 to $499	2,511	25.6
$500 to $749	2,796	28.5
$750 to $999	934	9.5
$1,000 to $1,499	1,014	10.3
$1,500 or more	203	2.1
No cash rent	212	2.2
Median (dollars)	(X)	(X)
GROSS RENT AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	1,782	18.2
15.0 to 19.9 percent	1,286	13.1
20.0 to 24.9 percent	949	9.7
25.0 to 29.9 percent	1,126	11.5
30.0 to 34.9 percent	754	7.7
35.0 percent or more	3,248	33.1
Not computed	664	6.8

(X) - Not applicable, or statistic not calculated by summarize function



Fairbank Hwy Research C
Central Intelligence Agency
Chesapeake and Ohio Canal
Snake Isle
SENTINEL DRIVE, 5005-5007
Montgomery, MD
Little Falls Mall
Maryland
Sangamore Ct
SANGAMORE ROAD 4511 4521
Potomac River
Snake Island
Dalecarlia Reservoir
High Island
Immanuel Presbyterian Church
George Washington Memorial Pkwy
Dalecarlia Reservoir
District of Columbia, DC
NAVAL SECURITY STATION
US ARMY CORPS OF ENGINEERS DALECARLIA WTP AQUEDUCT
Fairfax, VA
Virginia
Pimmit Run
CHU CLEANERS
Arlington, VA
Potomac River
Marie Butler Leven Preserve
Little Pimmit Run
Battery Kimble Creek
Ellicott St NW
Davenport St NW
Chesapeake St NW
Brandywine St NW
Butterworth Pl NW
Albemarle St NW
Alton Pl NW
Yuma St NW
Windom Pl NW
Warren St NW
Verplanck Pl NW
Van Ness St NW
Norton St NW
Loughboro Rd NW
Rockwood Pky NW
Hawthorne Ln NW
Hawthorne St NW
Forest Ln NW
Edmunds St NW
Chain Bridge Rd NW
Dalecarlia Pky NW
MacArthur Blvd
Crimson Ct
Valley Rd
Newport Ave
Cammack Dr
Falmouth Rd
Carvel Rd
Dalecarlia Dr
Albemarle St
Westmoreland Cir
Massachusetts Ave NW
Nebraska Ave NW
Klingle St NW
Woodway Ln NW
Hillbrook Ln NW
Indian Ln NW
Millwood Ln NW
Watson St NW
Partridge Ln NW
Dolly Madison Blvd
Chain Bridge Rd
Crest Ln
Kirby Rd
Claiborne Dr
Woodacre Dr
Meric Rd
Ingeborg Ct
Loch Raven Dr
Rachel Rd
Long Meadow Rd
Ramsgate Ter
Savile Ln
Litton Ln
Basil Rd
Oris St
Forest Ct
N Glebe Rd
40th St N

LandView 6 - Census 2000 Profile of General Demographic Characteristics DP-1 (100%)

Summary of Census Block Groups # records summarized: 5

Total population: 7,548 Total Housing Units: 3,156 Persons per sq. mi: 3,536.0

Population estimate for radius: 1 miles (38.940189, -77.115456)

	Number	PCT
SEX AND AGE		
Male	3,578	47.4
Female	3,970	52.6
Under 5 years	431	5.7
Age 5 to 9 years	512	6.8
Age 10 to 14 years	496	6.6
Age 15 to 19 years	378	5.0
Age 20 to 24 years	194	2.6
Age 25 to 34 years	554	7.3
Age 35 to 44 years	1,084	14.4
Age 45 to 54 years	1,372	18.2
Age 55 to 59 years	686	9.1
Age 60 to 64 years	412	5.5
Age 65 to 74 years	675	8.9
Age 75 to 84 years	593	7.9
Age 85 years and over	161	2.1
Median age	(X)	(X)
Age 18 years and over	5,818	77.1
Male	2,649	35.1
Female	3,169	42.0
Age 21 years and over	5,701	75.5
Age 62 years and over	1,664	22.0
Age 65 years and over	1,429	18.9
Male	634	8.4
Female	795	10.5
RACE		
One race	7,438	98.5
White	6,907	91.5
Black or African American	183	2.4
American Indian and Alaska Native	13	0.2
Asian	263	3.5
Asian Indian *	(X)	(X)
Chinese *	(X)	(X)
Filipino *	(X)	(X)
Japanese *	(X)	(X)
Korean *	(X)	(X)
Vietnamese *	(X)	(X)
Other Asian * [1]	(X)	(X)
Native Hawaiian and Other Pacific Is.	4	0.1
Native Hawaiian *	(X)	(X)
Guamanian or Chamorro *	(X)	(X)
Samoan *	(X)	(X)
Other Pacific Islander * [2]	(X)	(X)
Some other race	68	0.9
Two or more races	110	1.5
RACE alone or combined with one or more other races [3]		
White	7,004	92.8
Black or African American	212	2.8
American Indian and Alaska Native	19	0.3
Asian	313	4.1
Native Hawaiian and Other Pacific Is.	11	0.1
Some other race	99	1.3

	Number	PCT
HISPANIC OR LATINO AND RACE		
Hispanic or Latino (of any race)	394	5.2
Mexican *	(X)	(X)
Puerto Rican *	(X)	(X)
Cuban *	(X)	(X)
Other Hispanic or Latino *	(X)	(X)
Not Hispanic or Latino	7,154	94.8
White alone	6,592	87.3
RELATIONSHIP		
In households	7,540	99.9
Householder	3,066	40.6
Spouse	1,958	25.9
Child	1,973	26.1
Own child under 18 years	1,688	22.4
Other relatives	107	1.4
Under 18 years	23	0.3
Nonrelatives	436	5.8
Unmarried partner *	(X)	(X)
In group quarters	8	0.1
Institutionalized population	0	0.0
Noninstitutionalized population	8	0.1
HOUSEHOLDS BY TYPE		
Total households	3,066	100
Family households (families)	2,163	70.5
With own children under 18 yrs	935	30.5
Married couple family	1,958	63.9
With own children under 18 yrs	821	26.8
Female householder, no husband present	164	5.3
With own children under 18 yrs	90	2.9
Nonfamily households	903	29.5
Householder living alone	750	24.5
Householder 65 years and over	365	11.9
Households with persons under 18 years	961	31.3
Households with persons 65 yrs. and over	1,009	32.9
Average household size	(X)	(X)
Average family size	(X)	(X)
HOUSING OCCUPANCY		
Total housing units	3,156	100
Occupied housing units	3,066	97.1
Vacant housing units	90	2.9
For seasonal/recreational/occasional use	28	0.9
Homeowner vacancy rate (percent)	(X)	(X)
Rental vacancy rate (percent)	(X)	(X)
HOUSING TENURE		
Occupied housing units	3,066	100
Owner-occupied	2,626	85.6
Renter-occupied	440	14.4
Average household size, owner occupied units	(X)	(X)
Average household size, renter occupied units	(X)	(X)
LAND AREA		
Square Miles	2.13	
Square Kilometers	5.53	

(X) - Not applicable, or statistic not calculated by summarize function * These fields not available at Block Group level

1 Other Asian alone, or two or more Asian categories.

2 Other Pacific Islander alone, or two or more Native hawaiian and Other Pacific Islander categories.

3 In combination with one or more races listed. The following six numbers may add to more than the total population and the six percentages may add to more than 100 percent because individuals may report more than one race.

LandView 6 - Census 2000 Profile of Selected Social Characteristics (DP-2)

Summary of Census Block Groups — # records summarized 5

Population estimate for radius: 1 miles (38.940189, -77.115456)

SCHOOL ENROLLMENT	Number	PCT
Population 3 years and over enrolled in school	1,804	100.0
Nursery school, preschool	257	14.2
Kindergarten	66	3.7
Elementary school (grades 1-8)	823	45.6
High school (grades 9-12)	332	18.4
College or graduate school	326	18.1
EDUCATIONAL ATTAINMENT		
Population 25 years and over	5,481	100.0
Less than 9th grade	33	0.6
9th to 12th grade, no diploma	44	0.8
High school graduate (incl. equiv.)	286	5.2
Some college, no degree	422	7.7
Associate degree	118	2.2
Bachelor's degree	1,865	34.0
Graduate or professional degree	2,713	49.5
Percent high school graduate or higher	98.6	(X)
Percent bachleor's degree or higher	83.5	(X)
MARITAL STATUS		
Population 15 years and over	6,058	100.0
Never married	1,203	19.9
Now married, except separated	4,092	67.5
Separated	56	0.9
Widowed	355	5.9
Female	290	4.8
Divorced	352	5.8
Female	262	4.3
GRANDPARENTS AS CAREGIVERS		
Grandparent living in household with one or more own grandchildren under 18 years *	(X)	(X)
Grandparent responsible for grandchildren *	(X)	(X)
VETERAN STATUS		
Civilian population 18 years and over	5,781	100.0
Civilian veterans	765	13.2
DISABILITY STATUS OF THE CIVILIAN NONINSTITUTIONALIZED POPULATION		
Population 5 to 20 years	1,370	100.0
With a disability	90	6.6
Population 21 to 64 years	4,341	100.0
With a disability	257	5.9
Percent employed	(X)	(X)
No disability	4,084	94.1
Percent employed	(X)	(X)
Population 65 years and over	1,322	100.0
With a disability	288	21.8
RESIDENCE IN 1995		
Population 5 years and over	7,040	100.0
Same house in 1995	4,141	58.8
Different house in the U.S./Puerto Rico in 1995	2,442	34.7
Same county/municipio (PR)	1,345	19.1
Different county/municipio (PR)	1,097	15.6
Same state/Outside PR in 1995	19	0.3
Different state/United States (PR)	1,078	15.3
Elsewhere/Elsewhere (PR) in 1995	457	6.5

NATIVITY AND PLACE OF BIRTH	Number	PCT
Total population	7,511	100.0
Native	6,214	82.7
Born in United States/Puerto Rico	6,066	80.8
State of residence/Born in the U.S. (PR)	1,396	18.6
Different state/Born in U.S. Island Areas (PR)	4,670	62.2
Born outside U.S./Born abroad of Amer...(PR)	148	2.0
Foreign born	1,297	17.3
Entered 1990 to March 2000	553	7.4
Naturalized citizen	438	5.8
Not a citizen	859	11.4
REGION OF BIRTH OF FOREIGN BORN		
Total population (excl. born at sea)	(X)	(X)
Europe *	(X)	(X)
Asia *	(X)	(X)
Africa *	(X)	(X)
Oceania *	(X)	(X)
Latin America *	(X)	(X)
Northern America *	(X)	(X)
LANGUAGE SPOKEN AT HOME		
Population 5 years and over	7,040	100.0
English only	5,848	83.1
Language other than English	1,192	16.9
Speak English less than "very well"	370	5.3
Spanish	349	5.0
Speak English less than "very well"	104	1.5
Other Indo-European languages	659	9.4
Speak English less than "very well"	196	2.8
Asian and Pacific Island languages	140	2.0
Speak English less than "very well"	70	1.0
ANCESTRY (single or multiple)		
Total population *	(X)	(X)
*Total ancestries reported **	(X)	(X)
Arab *	(X)	(X)
Czech * 1	(X)	(X)
Danish *	(X)	(X)
Dutch *	(X)	(X)
English *	(X)	(X)
French (except Basque) * 1	(X)	(X)
French Canadian * 1	(X)	(X)
German *	(X)	(X)
Greek *	(X)	(X)
Hungarian *	(X)	(X)
Irish * 1	(X)	(X)
Italian *	(X)	(X)
Lithuanian *	(X)	(X)
Norwegian *	(X)	(X)
Polish *	(X)	(X)
Portuguese *	(X)	(X)
Russian *	(X)	(X)
Scotch-Irish *	(X)	(X)
Scottish *	(X)	(X)
Slovak *	(X)	(X)
Subsaharan African *	(X)	(X)
Swedish *	(X)	(X)
Swiss *	(X)	(X)
Ukrainian *	(X)	(X)
United States or American *	(X)	(X)
Welsh *	(X)	(X)
West Indian (excluding Hispanic groups) *	(X)	(X)
Other ancestries *	(X)	(X)

(X) - Not applicable, or statistic not calculated by summarize function   * These fields not available at Block Group level

1 The data represent a combination of two ancestries shown separately in Summary File 3. Czech includes Czechoslovakian. French includes Alsatian. French Canadian includes Acadian/Cajun. Irish includes Celtic.

LandView 6 - Census 2000 Profile of Selected Economic Characteristics (DP-3)

Summary of Census Block Groups # records summarized: 5

Population estimate for radius: 1 miles (38.940189, -77.115456)

EMPLOYMENT STATUS	Number	PCT
Population 16 years and over	5,974	100.0
In labor force	3,768	63.1
Civilian labor force	3,761	63.0
Employed	3,737	62.6
Unemployed	24	0.4
Percent of civilian labor force	0.6	(X)
Armed Forces	7	0.1
Not in labor force	2,206	36.9
Females 16 years and over	3,212	100.0
In labor force	1,743	54.3
Civilian labor force	1,743	54.3
Employed	1,725	53.7
Own children under 6 years	579	100.0
All parents in family in labor force	374	64.6
COMMUTING TO WORK		
Workers 16 years and over	3,718	100.0
Car, truck, or van -- drove alone	2,382	64.1
Car, truck, or van -- carpooled	261	7.0
Public transportation (including taxicab)	324	8.7
Walked	59	1.6
Other means	107	2.9
Worked at home	585	15.7
Mean travel time to work (minutes) [1]	(X)	(X)
Employed civilian population 16 years and over	3,737	100.0
OCCUPATION		
Management, professional, and related occupations	2,914	78.0
Service occupations	228	6.1
Sales and office occupations	507	13.6
Farming, fishing, & forestry occupations	0	0.0
Construction, extraction, and maintenance occupations	42	1.1
Production, transportation, and material moving occupations	46	1.2
INDUSTRY		
Agriculture, forestry, fishing, hunting, and mining	0	0.0
Construction	83	2.2
Manufacturing	27	0.7
Wholesale trade	23	0.6
Retail trade	177	4.7
Transportation and warehousing, and utilitites	26	0.7
Information	275	7.4
Finance, insurance, real estate, and rental and leasing	587	15.7
Professional, scientific, management, administrative, and waste management services	1,104	29.5
Educational, health, and social services	554	14.8
Arts, entertainment, recreation, accomodation, and food services	112	3.0
Other services (except public administration)	392	10.5
Public administration	377	10.1
CLASS OF WORKER		
Private wage and salary workers	2,694	72.1
Government workers	519	13.9
Self-employed workers in own not incorporated business	503	13.5
Unpaid family workers	21	0.6

INCOME IN 1999	Number	PCT
Households	2,996	100.0
Less than $10,000	44	1.5
$10,000 to $14,999	14	0.5
$15,000 to $24,999	81	2.7
$25,000 to $34,999	96	3.2
$35,000 to $49,999	150	5.0
$50,000 to $74,999	386	12.9
$75,000 to $99,999	333	11.1
$100,000 to $149,999	529	17.7
$150,000 to $199,999	384	12.8
$200,000 or more	979	32.7
Median household income (dollars)	(X)	(X)
With earnings	2,454	81.9
Mean earnings (dollars) [1]	(X)	(X)
With Social Security income	821	27.4
Mean Social Security income (dollars) [1]	(X)	(X)
With Supplemental Security Income	24	0.8
Mean Supplemental Security income (dollars) [1]	(X)	(X)
With public assistance income	0	0.0
Mean public assistance income (dollars) [1]	(X)	(X)
With retirement income	733	24.5
Mean retirement income (dollars) [1]	(X)	(X)
Families	2,146	100.0
Less than $10,000	10	0.5
$10,000 to $14,999	0	0.0
$15,000 to $24,999	24	1.1
$25,000 to $34,999	39	1.8
$35,000 to $49,999	48	2.2
$50,000 to $74,999	188	8.8
$75,000 to $99,999	238	11.1
$100,000 to $149,999	374	17.4
$150,000 to $199,999	347	16.2
$200,000 or more	878	40.9
Median family income (dollars)	(X)	(X)
Per capita income (dollars) [1]	(X)	(X)
Median earnings (dollars):		
Male full-time, year-round workers *	(X)	(X)
Female full-time, year-round workers *	(X)	(X)

Subject	Number below poverty level	Percent below poverty level
POVERTY STATUS IN 1999		
Families	10	0.5
With related children under 18 years	0	(X)
With related children under 5 years	0	(X)
Families with female householder, no husband present	0	(X)
With related children under 18 years	0	(X)
With related children under 5 years	0	(X)
Individuals	174	(X)
18 years and over	174	(X)
65 years and over	24	(X)
Related children under 18 years *	(X)	(X)
Related children 5 to 17 years *	(X)	(X)
Unrelated individuals 15 years and over *	(X)	(X)

(X) - Not applicable, or statistic not calculated by summarize function   * These fields not available at Block Group level

1 If the denominator of a mean value or per capita value is less than 30, then that value is calculated using a rounded aggregate in the numerator.

LandView 6 - Census 2000 Profile of Selected Housing Characteristics (DP-4)

Summary of Census Block Groups

records summarized: 5

Population estimate for radius: 1 miles (38.940189, -77.115456)

	Number	PCT
Total housing units	3,160	100.0
UNITS IN STRUCTURE		
1-unit, detached	2,338	74.0
1-unit, attached	122	3.9
2 units	13	0.4
3 or 4 units	21	0.7
5 to 9 units	60	1.9
10 to 19 units	222	7.0
20 or more units	376	11.9
Mobile home	3	0.1
Boat, RV, van, etc.	5	0.2
YEAR STRUCTURE BUILT		
1999 to March 2000	43	1.4
1995 to 1998	54	1.7
1990 to 1994	50	1.6
1980 to 1989	189	6.0
1970 to 1979	572	18.1
1960 to 1969	411	13.0
1940 to 1959	1,187	37.6
1939 or earlier	654	20.7
ROOMS		
1 room	7	0.2
2 rooms	27	0.9
3 rooms	120	3.8
4 rooms	158	5.0
5 rooms	232	7.3
6 rooms	519	16.4
7 rooms	279	8.8
8 rooms	458	14.5
9 rooms or more	1,360	43.0
Median (rooms)	(X)	(X)
Occupied housing units	3,062	100.0
YEAR HOUSEHOLDER MOVED INTO UNIT		
1999 to March 2000	416	13.6
1995 to 1998	758	24.8
1990 to 1994	475	15.5
1980 to 1989	553	18.1
1970 to 1979	484	15.8
1969 or earlier	376	12.3
VEHICLES AVAILABLE		
None	100	3.3
1	905	29.6
2	1,611	52.6
3 or more	446	14.6
HOUSE HEATING FUEL		
Utility gas	2,362	77.1
Bottled, tank, or LP gas	5	0.2
Electricity	548	17.9
Fuel oil, kerosene, etc.	124	4.1
Coal or coke	0	0.0
Wood	0	0.0
Solar energy	0	0.0
Other fuel	9	0.3
No fuel used	14	0.5
SELECTED CHARACTERISTICS		
Lacking complete plumbing facilities	0	0.0
Lacking complete kitchen facilities	0	0.0
No telephone service	8	0.3

	Number	PCT
OCCUPANTS PER ROOM		
Occupied housing units	3,062	100.0
1.00 or less	3,062	100.0
1.01 to 1.50	0	0.0
1.51 or more	0	0.0
Specified owner-occupied units	2,085	100.0
VALUE		
Less than $50,000	7	0.3
$50,000 to $99,999	0	0.0
$100,000 to $149,000	23	1.1
$150,000 to $199,999	17	0.8
$200,000 to $299,999	146	7.0
$300,000 to $499,999	437	21.0
$500,000 to $999,999	1,222	58.6
$1,000,000 or more	233	11.2
Median (dollars)	(X)	(X)
MORTGAGE STATUS AND SELECTED MONTHLY OWNER COSTS		
With a mortgage	1,504	72.1
Less than $300	0	0.0
$300 to $499	6	0.3
$500 to $699	13	0.6
$700 to $999	23	1.1
$1,000 to $1,499	93	4.5
$1,500 to $1,999	252	12.1
$2,000 or more	1,117	53.6
Median (dollars)	(X)	(X)
Not mortgaged	581	27.9
Median (dollars)	(X)	(X)
SELECTED MONTHLY OWNER COSTS AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	1,025	49.2
15.0 to 19.9 percent	281	13.5
20.0 to 24.9 percent	194	9.3
25.0 to 29.9 percent	186	8.9
30.0 to 34.9 percent	109	5.2
35.0 percent or more	290	13.9
Not computed	0	0.0
Specified renter-occupied units	422	100.0
GROSS RENT		
Less than $200	0	0.0
$200 to $299	0	0.0
$300 to $499	7	1.7
$500 to $749	65	15.4
$750 to $999	164	38.9
$1,000 to $1,499	34	8.1
$1,500 or more	111	26.3
No cash rent	41	9.7
Median (dollars)	(X)	(X)
GROSS RENT AS A PERCENTAGE OF HOUSEHOLD INCOME IN 1999		
Less than 15.0 percent	131	31.0
15.0 to 19.9 percent	71	16.8
20.0 to 24.9 percent	31	7.3
25.0 to 29.9 percent	23	5.5
30.0 to 34.9 percent	23	5.5
35.0 percent or more	102	24.2
Not computed	41	9.7

(X) - Not applicable, or statistic not calculated by summarize function

Excerpts from:

Final Environmental Impact Statement for a Proposed Water Treatment Residuals Management Process for the Washington Aqueduct, Washington, D.C.

September 2005

Washington Aqueduct
Baltimore District USACE

3.12 Socioeconomic and Environmental Justice

The socioeconomic indicators used for this EIS include regional economic activity, population, and housing data that characterize the region of influence (ROI) and surrounding counties. An ROI is a geographic area selected as the basis of analysis for demographic and economic impacts. In addition, local recreation, schools, public safety, and related community services are discussed.

The ROI for the proposed action is the 2000 Metropolitan Washington Council of Governments (MWCOG) region, which consists of the greater Washington, DC, metropolitan area. Within the ROI, the areas surrounding facility where any changes in demand for community service would most likely occur are the District of Columbia's northwest sector and the Montgomery County, Maryland Bethesda-Chevy Chase planning area.

Year 2000 Census data were used as the baseline for socioeconomic indicators, unless more recent data were available from other sources.

3.12.1 Economic Development

The total workforce for the ROI is around 2.4 million. The area's predominant industries include services; trade, transportation, and utilities (TTU); and government. The economy itself is quite robust, with low unemployment levels. The highest unemployment rate was found in the District of Columbia, with 6.8 percent recorded in 2000. The remaining counties varied between 1.6 percent (Loudoun County) and 4.1 percent (Prince George's County) (U.S. Census, 2000).

With the nation's capital as the hub of the ROI, a significant portion of the economy revolves around federal spending and procurement. In 2002 alone, over $87.5 billion was spent, with 43 percent or $37.3 billion awarded to private contractors (Economic Trends in Metropolitan Washington, MWCOG).

Another factor highlighting the substantial economic activity of the ROI is construction. Commercial development was 33.2 million square feet for 2002 and residential permits for new housing units reached 34,967 new licenses (Economic Trends in Metropolitan Washington, MWCOG).

In the central jurisdictions of the MWCOG region, construction of 7.5 million square feet (valued at $843 million) of office space, 2.1 million ft^2 ($334 million) of educational and medical space, and 1.8 million ft^2 ($468 million) of other commercial space began in 2002. These Figures do not include utility-related facilities such as the Washington Aqueduct project, which is budgeted at approximately $50 million, a relatively small amount in the context of regional construction activity.

Northern Virginia led the region in new construction projects, but in the District of Columbia alone, 44 new construction projects were added in 2002, contributing 19 percent of new commercial construction in the region, worth $1.2 billion. In Montgomery County Maryland, $636 million in new projects were recorded, with 7.9 million square feet being built (Commercial Construction Indicators [CCI], MWCOG).

Regional data reveals that most major construction projects are commercial. In the DC area, such projects are concentrated in the central areas of the District, while the major projects in Montgomery County Maryland are several miles north of the proposed project site. No projects greater than 50,000 square feet were undertaken within 1 mile of Dalecarlia in 2002 (CCI, MWCOG).

In 2002, the District of Columbia employed a total of 14,604 workers in the construction industry and 209,383 construction workers were employed in the Washington-Arlington-Alexandria, DC-VA-MD-WVA Metropolitan Statistical Area (MSA) (Bureau of Economic Analysis, 2002).

3.12.2 Demographics

Population trends within the ROI have been similar to national trends, with population shifting from central cities to suburban areas and suburban development spreading into the surrounding rural areas. From 1990 to 2000, the total population of the MWCOG region grew at 13.4 percent to 4.5 million people. The District of Columbia itself experienced the smallest increase in population (6.5 percent) within the ROI. In contrast, the surrounding suburbs have grown at a rapid pace, with nine of the remaining twelve municipalities experiencing double digit growth from 1990 to 2000 (Our Changing Region, MWCOG).

Looking forward, the population of the region as a whole is projected to grow 21 percent by the year 2015. The District of Columbia is expected to have the smallest population increase (2.9 percent), while half of the remaining counties, including Montgomery County Maryland, will continue to experience double digit growth (Our Changing Region, MWCOG).

3.12.3 Housing

Since the proposed project site is strictly limited to the water treatment facilities themselves, the supply of housing in the region is not a factor in this process. Overall, a total of 1,684,215 total housing units were recorded in the MWCOG for 2000, with 1,607,261 of those housing units being occupied (4.6 percent vacancy rate). In the District of Columbia as a whole, a total of 274,845 units were present, with 248,338 units being occupied (9.6 percent vacancy rate) (Our Changing Region, MWCOG).

3.12.4 Quality of Life

3.12.4.1 Law Enforcement Services

Law enforcement support is provided to DC by the Metropolitan Police force. The Police headquarters for the project site is located in District Two, 3320 Idaho Ave, NW. This office oversees the operations of seven subdistricts, including those that have jurisdiction over Dalecarlia (subdistrict 202) and the Georgetown Reservoir (subdistrict 206). Residents are asked to report any crimes, incidents, accidents or suspicious individuals or activity to this station. In the case of an emergency, residents should call 911, which will be routed back to District Two headquarters for a response.

Within the MWCOG region, law enforcement is administered separately by each county or independent city. Intergovernmental measures to coordinate law enforcement, when needed, are in place under local homeland security programs and cooperative agreements (Metropolitan [DC] Police Department Web site).

3.12.4.2 Fire Protection Services

The fire protection and Emergency Medical Service (EMS) services within the District are provided by 32 fire and EMS stations. The facility located closest to Georgetown and Dalecarlia is Engine Company 29, 5th Battalion, on 4811 MacArthur Boulevard, NW. The station is staffed by nine firefighters, one fire engine, and one fire truck, and operates with a mutual aid agreement with all surrounding counties in the area, including Montgomery County Maryland. The closest station with EMS capabilities is Engine Company 5, 5th Battalion, on 3412 Dent Place NW, which is located in the vicinity of Georgetown University. A hazardous material unit is located at 5th and Rhode Island NE. All stations are brush-fire capable (District of Columbia Fire and Emergency Medical Services [DC FEMS] Web site, 2004).

Within the greater MWCOG region, fire and medical services are provided by each county separately, with regional coordination measures in place for emergencies (DC FEMS Web site, 2004).

3.12.4.3 Medical Services

The closest full-service hospital is Sibley Memorial Hospital, located immediately across from Dalecarlia. The fully accredited facility maintains a 13 bedroom Emergency Room center and treated over 24,000 patients last year (Sibley Memorial Hospital Site, 2004).

Georgetown University Hospital is a fully staffed facility that provides immediate care, emergency treatment, walk-in care, and a wide variety of other services. The hospital is located close to the Georgetown Reservoir and is also within service area for Dalecarlia. Riverside Hospital is also near the Georgetown Reservoir project site (Sibley Memorial Hospital Web site, 2004).

The nearest hospital to the Blue Plains AWWTP site is Hadley Memorial Hospital. Greater Southeast Hospital is also within the service area, about two miles away. Greater Southeast is a full-service acute care hospital that offers a wide range of inpatient, outpatient and emergency medicine services (DC Chamber of Commerce website, 2004).

3.12.4.4 Schools

Georgetown and Dalecarlia are in close proximity to several schools and educational centers. Dalecarlia is within 1 mile of Wesley Seminary, and 1.2 miles of Key Elementary School. Seven academic facilities are within a 1-mile radius of Georgetown Reservoir, including Georgetown University, Georgetown Day School, Hardy Middle School, Harrison School, Woodmont School, Mt. Vernon Junior College, and Conduit Road Seminary. The pipeline route bypasses several schools, including the aforementioned facilities, George Washington University, and twelve additional schools (LandView6®, 2004). Nearly 1.2 million inhabitants of the MWCOG region are enrolled in school, 157,475 of whom are DC residents (Our Changing Region, MWCOG).

3.12.4.5 Shops and Services

With the MWCOG's large population and busy economy, there are a wide variety of shops and services available within the greater DC area. In the immediate area, the Spring Valley Shopping Center provides the community with several small scale retailers. Along the pipeline route, there are several shops and retail services, particularly in the Georgetown University area. The Les Champs Shopping Mall sits on the shoreline of the Potomac, also along the pipeline.

The final third of the pipeline route does not affect shops and services at all (LandView6®, 2004).

3.12.4.6 Recreation

Numerous recreational facilities are available, within a 1-mile radius of both reservoirs, for families, children, and retirees. The following recreational opportunities are available (LandView6®, 2004):

- Capital Crescent Trail (Dalecarlia)
- Spring Valley Park (Dalecarlia)
- C&O Canal National Park (Dalecarlia and Georgetown)
- Friendship Recreation Center (Dalecarlia)
- Little Falls Branch (Dalecarlia)
- Chesapeake Canal (Dalecarlia)
- Hardy Playground (Georgetown)
- Georgetown Reservoir Playground (Georgetown)
- Hardy Recreation Center
- Palisades Community Center
- Westmoreland Playground

The Capital Crescent Trail is a bicycling/jogging trail that runs from suburban Maryland to downtown DC. It has its own right-of-way and bridges and is fenced off from Dalecarlia. The trail's proximity to the Dalecarlia Reservoir, the Dalecarlia Water Treatment Plant, and the Georgetown Reservoir is shown in Figure 3-34. The trail is extremely popular with cyclists (both recreational and commuting), jogging enthusiasts, walkers, and children.

On the Georgetown side, the reservoir adjoins the boundaries of the C&O Canal National Park, another local and regional resource for recreational cyclists, joggers, and walkers.

Several major parks and monuments are in close proximity to the pipeline route. In addition to the aforementioned park areas, the pipeline route also passes through Rock Creek Park and is close to East Potomac Park, James Monroe Park, the Jefferson Memorial, and the National Mall, as well as recreation centers and playgrounds (LandView6®, 2004). Many of the sensitive receptors found near the Potomac Interceptor route are shown in Figures 3-35a, 3-35b, 3-35c, and 3-35d. Table 3-11 (next page) lists parks and other sensitive receptors that are located near relevant areas north of the Chesapeake Bay and into the state of Delaware.

TABLE 3-11
Public Facilities

Name	Type
Dalecarlia	
Wesley Seminary	School
Crescent Trail	Park
Spring Valley Park	Park
C&O Canal National Park	Reserve
Friendship Recreation Center	Recreation
Little Falls	River
Chesapeake Canal	River
Georgetown	
Hardy Middle School	School
Georgetown Day School	School
Georgetown University	School
Harrison School	School
Woodmont School	School
Mt. Vernon Junior College & Seminary	School
Conduit Road School	School
Hardy Playground	Park
Reservoir Playground	Park
C&O Canal National Park	Reserve
Hardy Recreation Center	Recreation
Riverside Hospital	Hospital
Georgetown University Hospital	Hospital
Engine Company 29	Fire
Pipeline Route	
Key Elementary School	School
Prospect Learning Center	School
Hyde Elementary School	School
Saint Stevens School	School
Saint Stephens School	School
Stevens Junior High School	School
Francis Junior High School	School
George Washington University	School
Schools Without Walls Senior High School	School
Jefferson Junior High School	School
Hawthorne High School	School
Leckie Elementary School	School
Patterson Elementary School	School
National Mall	Feature
Reflecting Pool	Feature
East Potomac Park	Park
International Athletic Park	Park
C&O Canal National Park	Reserve
Palisades Park and Recreation Center	Recreation
The Potomac Gorge	Park
Georgetown Playground and Recreation Center	Park
Georgetown Waterfront Park	Park
Rock Creek Park	Park
James Monroe Park	Park
Lincoln Memorial	Park
West Potomac Park	Park
Jefferson Memorial	Park
Potomac River	River
Rock Creek	River
Anacostia River	River

Source: U.S. Bureau of the Census, USGS and USEPA: LandView6®

3.12.5 Environmental Justice

On February 11, 1994, President Clinton signed EO 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations." The purpose of this order is to require each federal agency to identify and address any disproportionately high and adverse environmental or economic effects that its programs and policies might have on minority or low-income populations. *Environmental Justice: Guidance Under the National Environmental Policy Act* (Council of Environmental Quality [CEQ], 1997) defines minorities as members of the following population groups: American Indian or Alaskan Native, Asian or Pacific Islander, Black or African American, or Hispanic. Any minority population in the affected area should be identified if it exceeds 50 percent or is meaningfully greater than the minority population percentage in the general population.

Low-income populations are identified using the Census Bureau's statistical poverty threshold, which varies by household size and number of children. For example, the 2000 poverty threshold for a family of four with two children was $17,463. The nationwide poverty rate was 12.4 percent at the 2000 Census and 11.7 percent in 2001 (U.S. Census, 2000). The Census Bureau defines a "poverty area" as a census tract in which 20 percent or more of the residents have incomes below the poverty threshold and an "extreme poverty area" as one with 40 percent or more below the poverty level (U.S. Census, 2000).

To provide the baseline against which any environmental justice impacts can be identified and analyzed, Table 3-12 presents demographic information on race, ethnicity, and poverty status in the MWCOG region and in the areas immediately surrounding the proposed construction areas.

The MWCOG region is slightly more than half white (57 percent) with substantial African American (28.2 percent), growing Hispanic or Latino (9.7 percent), and stable Asian (7.6) minorities. The District of Columbia itself runs contrary to this trend, with a 60 percent African American majority and 31 percent white population. Despite such diversity, most counties in the region are predominantly white—the outer suburbs more so than the central jurisdictions closest to the city.

Although the surrounding jurisdictions (District of Columbia, Montgomery County Maryland, and Arlington County Virginia) are not defined as low-income areas, the District of Columbia has a higher poverty rate than the other jurisdictions in the MWCOG region (Census, 2000). In 2000, the overall poverty rate for individuals living in the District of Columbia was 16.9 percent, as compared to the rates of 7.6 percent for the region and 7.1 percent for the other central jurisdictions (LandView6®, 2004).

The census block groups (which are a subset of census tracts) comprising and immediately adjoining Dalecarlia and Georgetown, which include the neighborhood roads that potentially could be affected by truck traffic (see "best routes" identified in the Transportation subsection) under the residuals hauling alternatives, reflect a largely white population, unlike the majority African American population in the District of Columbia as a whole.

According to census block group data, these neighborhoods show 93 and 84 percent white-majority populations living around Dalecarlia and Georgetown, respectively. The

TABLE 3-12
Census 2000 Demographic Data for Washington Aqueduct and Surrounding Jurisdictions

	ROI (MWCOG Region)	District of Columbia	Montgomery County MD	Arlington County VA	Adjacent to Dalecarlia[3]	Adjacent to Georgetown[4]	Adjacent to Pipeline Route[5]	Adjacent to Blue Plains AWWTP[6]
Total Population 1990	3,923,600	537,218	989,655	170,936	–	–	–	–
Total Population 2000	4,450,300	572,059	873,341	189,453	909	4,264	14,913	6,869
Percent Change 1990-2000	13.4	6.5	15.4	10.8	–	–	–	–
Persons per square mile	1,474	9,317	1,762	7,323	–	–	–	–
Projected Growth 2015[1]	5,392,900	588,000	975,000	207,200	–	–	–	–
Percent Change 2000-2015[1]	21.2	2.8	11.6	9.4	–	–	–	–
Median Age (years)	34.9	34.6	36.8	34	–	–	–	–
Average household size	2.6	2.16	2.66	2.15	–	–	–	–
White (%)	57.0	30.8	64.8	68.9	93.3	83.9	75.6	8.2
Black or African American (%)	28.2	60.0	15.1	9.3	1.7	5.3	15.2	88.8
American Indian & Alaska Native (%)	0.3	0.3	0.3	0.3	0.0	0.3	0.4	0.2
Asian, Hawaiian and Other Pacific Islander (%)	7.6	2.7	11.3	8.6	4.4	8.9	4.8	0.9
Some other race (%)	4.0	3.8	5.0	8.3	0.7	0.4	2.0	0.7
Two or more races (%)	3.0	2.4	3.4	4.3	0.2	1.3	2.0	1.3
Hispanic or Latino Origin[2] (%)	9.7	7.9	11.5	18.6	4.7	5.2	6.7	2.1
Poverty Rate (%)	7.6	16.9	4.2	7.1	2.6	12.4	9.4	25[6]
Median Income	$42,726	$39,970	$49,107	$49,683	$117,552	$78,303	$89,458	not available[6]

Notes

1. Population projections are not available below the county/city level

2. Persons of Hispanic or Latino origin may be of any racial group and are also included in those percentages

3. Block Groups 1, 2, 6 and 7, Census Tract 9.01(DC) ; Block Groups 3 and 4, Census Tract 7057.02 (Montgomery County Maryland); Block Groups 1, 2 and 3, Census Tract 7058 (Montgomery County Maryland);environmental justice statistics only

4. Block Group 4, Census Tract 8.01 (DC); Block Groups 2 and 3, Census Tract 8.02 (DC); environmental justice statistics only

5. Block Group 4, Census Tract 1 (DC); Block Group 4, Census Tract 2.02 (DC); Block Group 4, Census Tract 8.01 (DC); Block Group 3, Census Tract 8.02 (DC); Block Group 7, Census Tract 9.01 (DC); Block Group 4, Census Tract 9.02 (DC); Block Group 1, Census Tract 62.02 (DC); Block Group 1, Census Tract 73.01 (DC); Block Group 1, Census Tract 73.08 (DC); Block Group 3, Census Tract 7057.02 (Montgomery County Maryland); environmental justice statistics only

6. Estimated by LandView® 6 Population Estimator, centered on the coordinates of pipeline terminus, using block points (demographics) and block group points (income and poverty). The summarize function does not calculate median income. Poverty rate is calculated only for families, not individuals (all other poverty rates shown are for individuals). With 1,824 individuals below poverty and based on total population in the 1-mile area, it would be about 27 percent.

Sources: U.S. Bureau of the Census, USGS and USEPA: LandView® 6 (Census 2000 data); MWCOG (projected growth 2015) largest minority in the adjacent area is the Hispanic or Latino population, with 4.4 and 8.9 percent populations around Dalecarlia and Georgetown, respectively (LandView6®, 2004).

These figures also run contrary to the surrounding MWCOG region's figures of a 57 percent white majority with an African American minority of 28.2 percent (U.S. Census, 2000).

The data for the census block groups around the reservoirs also show a largely upper-income population. With regards to income, the Dalecarlia area has a relatively high median income level of $117,552 (individual blocks varied from $96,000 to $198,000), with a poverty rate of 2.6 percent. The Georgetown Reservoir area's median income is $78,302 (ranging from $62,000 to $111,000), with a poverty rate of 12.4 percent. These can be compared to median incomes of $39,970 for the District of Columbia and $42,726 for the region. Although the poverty levels for both the Dalecarlia and Georgetown areas are lower than the District of Columbia's poverty level of 16.9 percent, the Georgetown Reservoir area's rate (12.4 percent) is higher than the regional average of 7.6 percent (LandView6®, 2004).

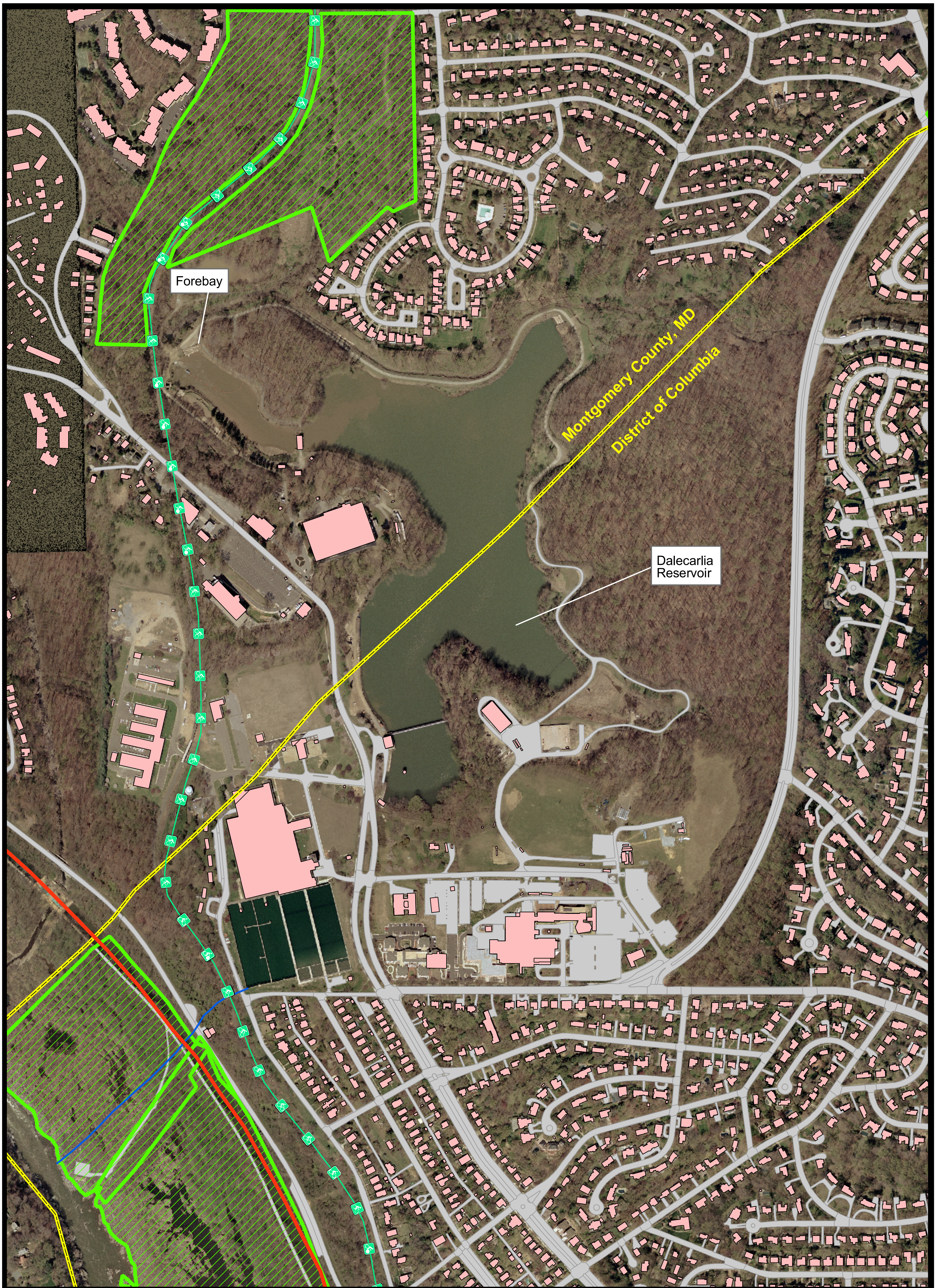
For the area that would be affected by the pipeline alternative, ten census block groups are involved with a wider variety of economic and social composition than the other affected areas. The overall population along the proposed pipeline route is 75.6 percent white, 15.2 percent African American, and 6.7 percent Hispanic or Latino, with smaller percentages of other races (LandView6®, 2004). Although these figures are somewhat more representative of the MWCOG region (57.7 percent white, 28.2 percent African American), the affected area is still anomalous when compared to the District of Columbia's African American majority of 60 percent (MWCOG, 2001). However, one of the affected block groups (Block Group 1, Tract 73.08) that would be crossed by the pipeline route has a higher African American majority population (82 percent, or 315 of 382 persons) than the District of Columbia as a whole.

Economically speaking, the pipeline route has average incomes ranging from $61,801 to $198,801, with an overall median income of $89,457. The overall poverty rate is 9.4 percent, ranging from 1.8 to 90.3 percent within individual blocks along the route. Eight of the ten blocks that would be traversed by the pipeline have poverty rates below the area average of 16.9 percent, while seven of the ten blocks are below the MWCOG level overall. However, two block groups affected (Block Group 1, Tract 73.08 and Block Group 4, Tract 2.02) have poverty levels of 90.4 percent and 33.2 percent respectively. Except for crossing these two block groups, the overall pipeline route avoids minority and low income areas (LandView6®, 2004).

The area (1-mile radius) surrounding the Blue Plains AWWTP (where the pipeline would end, a residuals processing plant would be built, and additional trucks would enter and exit from the Anacostia Freeway), has a population that is 8.2 percent white, 88.8 percent African American, and 2.1 percent Hispanic and Latino, with smaller percentages of other races,. About 25 percent of families in this area have incomes below the poverty threshold (LandView6®, 2004). DC Village, currently being used as a shelter for homeless families, is located within the 1-mile radius. Some of the housing at Bolling Air Force Base is also within the area. Although there is much variety within the neighborhoods in this portion of Ward 8, statistically the nearby area clearly meets the criteria for both a minority population and a poverty area.

3.12.6 Protection of Children

On April 21, 1997, the President issued EO 13045, "Protection of Children from Environmental Health Risks and Safety Risks," which seeks to protect children from disproportionately incurring environmental health or safety risks that might arise as a result of government policies, programs, activities, and standards. Children are present near Dalecarlia and Georgetown as residents in the area and as visitors in schools, parks, and recreation centers. The Washington Aqueduct has taken, and will continue to take, precautionary measures to reduce risk to children during construction and operation of facilities by providing fencing, security, and other means by which child interaction onsite can be prevented.



Legend

- Capital Crescent Bike Trail
- Approximate Potomac Interceptor Route
- District Boundary
- Approximate Location of the Discharge Pipe to the Potomac Interceptor
- Buildings
- Park
- Roads

The geographic information shown on this map is based on publicly available data from Montgomery County Maryland and the District of Columbia Geographic Information System (GIS) with GIS layers updated at different times. This figure is not intended to be a precise representation of the existing project site. Technical information on land use is evaluated elsewhere in the EIS. The District Government makes no warranty, express or implied, and disclaims all implied warranties of suitability of the DC GIS product for a particular purpose.

0 250 500 1,000
Feet

Figure 3-34
Park Locations Around Dalecarlia

this period, the views from the trail toward the Forebay would be altered by the presence of heavy construction equipment, stored building materials, and the activities of the construction workers. The installation of the dredge could be accomplished relatively quickly, limiting the visual impact. The pump station construction would take longer - perhaps one year. However, the proposed pump station location on the southern end of the Forebay minimizes visual impacts. Given the proximity of the construction area to the trail and the highly focused nature of the view, and the sensitivity of the trail's recreational users, the visual impacts would be substantial. However, because the construction activities will be short-term in nature, the action would have no significant adverse impact.

Impacts During the Operational Period

The proposed dredge will not alter the existing Forebay view since the Washington Aqueduct currently uses dredges to remove silt from the Forebay during the warmer months. The addition of a new below ground pump station at the southern end of the Forebay is also not anticipated to have a significant visual impact on the Forebay.

It is our finding that Forebay residuals treatment option would have no significant impact on visual aesthetics.

4.13 Socioeconomic and Environmental Justice

4.13.1 Definition

This section discusses potential social and economic impacts of implementing the alternatives. Socioeconomic impacts are linked through cause-and-effect relationships. Implementation of an action can affect socioeconomic conditions by changing the rate of population growth, the demographic characteristics of a community, or employment and income within the affected region. Government payrolls and local procurement contribute to the economic base for the region of influence (ROI). During the construction period, direct jobs will be created, generating new income and increasing personal spending. This spending generally creates secondary jobs, increases business volume, and can increase local revenues for schools and other social services. These effects cease when construction is completed. Ongoing changes in operational expenditures and jobs can create similar, long-term effects.

4.13.2 Socioeconomic Significance Criteria

Using the following criteria can identify the level of impacts:

No Impact

Implementation of the action would not appreciably affect population or regional economic activity. Regional economic modeling of direct, indirect, and induced growth is not required to determine significance of economic impacts. Minor population or employment growth is not enough to appreciably affect the demand for community services.

No Significant Impact

Implementation of the action would increase (or decrease) population or regional economic activity, but at a level consistent with historical fluctuations in population or economic indicators, as determined by regional economic modeling of direct, indirect and induced growth. Demand for community services may increase or decrease somewhat. Construction could disturb local business or recreational facilities at a level consistent with a typical construction project.

Significant Impact

Implementation of the action would increase or decrease population or regional economic activity above historical fluctuations in regional economic indicators, as determined by regional economic modeling. Implementation of the action would increase (or decrease) the demand for community services at levels that would require additional hiring (or layoffs) or cause overcrowding. Disruption of local business or recreational facilities would exceed that expected of a typical construction project. Significant Impacts may be reduced to a no significant level by implementing appropriate mitigation measures.

Specifically, an action could cause significant impacts to these resources by:

• Population	Causing regional population to exceed historic rates of growth or decline
• Employment	Causing regional employment to exceed historic fluctuation in rates of growth or decline, or reducing jobs enough to affect the regional unemployment rate
• Income	Changing regional income by more than historic fluctuation in rates of growth or decline
	Causing a substantial increase in fees for Washington Aqueduct customers due to construction costs
• Community services (housing, schools, police, fire, medical, retail, recreation)	Causing residential population change or peak increase in workforce (including short-term construction workforce) to substantially increase or decrease demand, at levels that would require hiring (or layoffs) of public service personnel or purchase of additional equipment, or would cause overcrowding
	Disrupting local business by construction activities/ traffic blocking business entrances or customer parking for more than four hours per day for an extended period of time
	Taking a substantial amount of land out of recreational use without in-kind replacement, or disruption of recreational facilities due to noise, dust, or blocking entrances more than four hours per day for an extended period of time
• Environmental Justice	Creating potential for serious health and safety effects disproportionately affecting minority or low-income populations
• Protection of Children	Potentially causing uncontrolled safety risks or serious health risks affecting children

As detailed in the following subsections, the impacts related to regional economy, demographic changes and related services (housing, schools, and public safety), environmental justice, and protection of children were evaluated.

4.13.3 Impact Evaluation by Alternative and Option

For this resource, impacts are described by alternative, rather than by both treatment facility and alternative. The discussion for each alternative includes the Dalecarlia Sedimentation Basins and Georgetown Reservoir areas.

Alternative A—Dewatering at Northwest Dalecarlia Processing Site and Disposal by Monofill

Economic Development

Minor beneficial effects on the local and regional economy would be expected. Construction expenditures would increase business volume in industries that supply material and services, many (but not all) of which would be in the Metropolitan Washington Council of Governments (MWCOG) region. In addition, convenience businesses (retail, fast food, gas stations) in the local area near the construction site would benefit from personal spending by construction workers in the vicinity.

Due to the sheer size of economic activity within the MWCOG region and the District of Columbia, however, the Washington Aqueduct project is highly unlikely to have any appreciable economic impact upon the regional economy. The total anticipated construction expenditures for the monofill alternative ($63 million) pales in comparison to the aggregate federal spending within the MWCOG region each year ($87.5 billion) (MWCOG, 2002).

The cost of construction for Alternative A represents about 1.7 percent of the total value of commercial construction starts in the region during 2001-2002 ($3.7 billion). These MWCOG CCI data do not include construction of facilities that serve a utility purpose or public works projects that do not provide additional space for employees, such as water supply and treatment buildings, landfills, pipelines or sewer projects (MWCOG, 2002). If such construction projects were included in the CCI, the relative percentage for the Washington Aqueduct project would be even lower.

Based on the construction cost estimates contained in this EIS, typical breakdown between labor and materials costs, and average construction wages in the region, construction of Alternative A would be expected to generate 165 full-time equivalent (FTE) construction jobs. With the large regional construction workforce within commuting distance of the work site, there would be no need for short-term employees to move into the area for the duration, however.

After construction, residuals processing and disposal in the monofill would generate only about 3.3 FTE permanent jobs and operations and maintenance expenditures of approximately $0.87 million each year, a miniscule amount in comparison to annual aggregate federal spending within the MWCOG region each year ($87.5 billion).

Demographics

Since the project sites themselves are located within the boundaries of the Washington Aqueduct properties and no employees are expected to move into the area as a result of this alternative, no population change is expected.

Housing

Construction employment would not be expected to generate any demand for short-term housing in the immediate area, because construction workers would commute daily to the work site from within the region. With the minimal increase in long-term employment, no appreciable effect on the local housing market would be expected. The Alternative A projects themselves are limited to the confines of the Washington Aqueduct property, thereby eliminating any chance of existing housing units being removed or altered.

Quality of Life

Some minor adverse effects to local recreational resources would be expected, along with some long-term beneficial effects, as described below. Construction traffic and noise would temporarily disturb residents living near Dalecarlia Reservoir. In addition, the view of the reservoir from the Capital Crescent Trail, as well as nearby residences, would be permanently altered, resulting in an adverse effect on visual resources. (See the Noise, Traffic, and Aesthetics and Visual Resources sections for more detailed discussion of these impacts.) The following paragraphs discuss effects on various community resources.

Law Enforcement, Fire, and Medical Services

No appreciable adverse effect on local public safety resources would be expected. Based on standard planning factors, the peak workload of 165 construction workers would generate only minimal additional demand for services of approximately 0.09 additional police FTEs, 0.07 additional fire fighter FTEs and 1.5 additional Emergency Medical Service (EMS) calls annually, for the three-year construction period.

Due to heightened security conditions after September 11th, a security contingency plan may be needed to protect the reservoir and WTP during the construction period. This could require some additional police/security personnel for the duration. However, the anticipated impact would be minimal.

Schools

No long-term adverse effect on local schools would be expected. There would be no population-driven change in school enrollments. However, minor short-term adverse effects are possible. In particular, noise and increased traffic could be a short-term nuisance to schools near the construction areas. Such effects are described in the Noise and Traffic sections.

Shops and Services

No long-term demand for shops and services would be expected to arise from the project. Since the area surrounding the proposed monofill site is almost exclusively residential, no major disruption to retail businesses in the area is expected. With the exception of Sibley Memorial Hospital, few other local businesses are located close enough to experience nuisance effects during construction. Local convenience businesses (retail, fast food, gas stations) would benefit from the additional construction workers in the area.

Recreation

Some impact to nearby recreation facilities would result from this alternative. With the construction of both a monofill on the reservoir property and the residuals treatment facility on the plant property, Capital Crescent Trail would be in close proximity to two construction sites. However, the entire property surrounding the water treatment facility is fenced off and removed from the trail and from Spring Valley Park, which is adjacent to the reservoir. A limited amount of open space available for passive and some active recreation may be temporarily reduced during construction. Noise and construction runoff could also be additional temporary nuisances.

Environmental Justice

Construction impacts are temporary in nature, but they can range from annoying to detrimental for those living near a construction site. None of the block groups immediately surrounding the two reservoir facilities are defined as minority or low-income areas (US Census, 2000). Therefore, no disproportionately adverse impacts to low-income and minority communities would be expected.

Protection of Children

In the short term, because construction sites can be enticing to children, construction activity could present be an unavoidable increased safety risk. Barriers and “no trespassing” signs will be placed around construction sites to deter children from playing in these areas. All construction vehicles, equipment and materials will be stored in fenced areas and secured when not in use. During construction, safety measures stated in 29 CFR 1926, Safety and Health Regulations for Construction, and other applicable regulations and guidance will be followed to protect the health and safety of residents surrounding the treatment facilities, as well as construction workers.

It is our finding that Alternative A would have no impact on socioeconomic and environmental justice issues.

Alternative B—Dewatering at Northwest Dalecarlia Processing Site and Disposal by Trucking

Economic Development

Like the other alternatives, Alternative B would result in minor beneficial effects on the local and regional economy, particularly to local convenience businesses during construction, but is would be unlikely to have any appreciable economic impact upon the regional economy. The cost of construction for Alternative B ($55.1 million) would represent from 1.5 percent of the total value of commercial construction starts in the region during 2001-2002 ($3.7 billion).

Alternative B would be expected to generate about 150 FTE construction jobs. With the large regional construction workforce within commuting distance of the work site, there would be no need for construction employees to move into the area during the three-year construction period.

After construction, residuals processing and contract hauling to a commercial landfill would generate only about 2.33 FTE permanent jobs and will require operations and maintenance expenditures of approximately $1.9 million each year, more than Alternative A (less than Alternative C), but still minor in comparison to annual aggregate federal spending within the MWCOG region each year ($87.5 billion).

Demographics

Since the project site is located within the boundaries of the water utility properties, and there would be no need for short-term or permanent employees to move into the area as a result of this alternative, no population change would be expected.

Housing

Construction employment would not be expected to generate any demand for short-term housing in the immediate area, because construction workers would commute daily to the work site from within the region. With the minimal increase in long-term employment, no appreciable effect on the local housing market would be expected. The Alternative B projects themselves are limited to the confines of the Washington Aqueduct property, thereby eliminating any chance of existing housing units being removed or altered.

Quality of Life

With the construction of the residuals treatment facility on the plant property, the Capital Crescent Trail would be in close proximity to one construction site. Construction traffic and noise would also temporarily disturb residents of the area. Unlike Alternative A, however, the view of the reservoir from the Capital Crescent Trail and nearby residences would not be permanently altered. Truck traffic would increase but analysis shows level of service, noise, safety, etc. would not be affected. (See the Noise, Traffic, and Aesthetics and Visual Resources sections for more detailed discussion of these impacts.)

Law Enforcement, Fire, and Medical Services

No appreciable adverse effect on local public safety resources would be expected. Based on standard planning factors, the peak workload of 150 construction workers could generate only minimal additional demand for services, requiring about 0.09 additional police, 0.06 additional fire fighters, and 1.5 additional EMS calls for the duration of the construction period. As previously mentioned, heightened security during the construction period could require a few more police/security personnel than estimated by standard planning factors. The impact would be expected to be minor.

Schools

No long-term adverse effect on local schools would be expected. There would be no population-driven change in school enrollments. However, noise and increased traffic could be a short-term nuisance to schools in the vicinity of construction areas. Such effects are described in the Noise and Traffic sections. There are schools in the vicinity of each of the existing truck routes as noted in Section 3. Because each route is an established truck route and the level of service will not be decreased as a result of the proposed residuals hauling operation, existing traffic controls and child safety measures presently in place should be adequate and as effective as they are currently. There are no adverse impacts on schools or child safety from truck hauling. There are few schools in the immediate vicinity of Dalecarlia Reservoir (see the Noise and Traffic sections).

Shops and Services

No long-term demand for shops and services would be expected to arise from the project. Since the area surrounding the Dalecarlia Reservoir is almost exclusively residential and construction at Georgetown Reservoir would not be expected to affect access to local businesses. Local convenience businesses (retail, fast food, gas stations) would benefit from the additional construction workers in the area.

Recreation

An adverse but not significant effect to nearby recreation facilities would result from the proposed action. Construction of the residuals processing facility at the Dalecarlia site would cause construction nuisances and noise adjacent to the Capital Crescent Trail. Nevertheless, the entire property surrounding the water treatment facility is fenced off from the trail and Spring Valley Park. Alternative B would not be expected to reduce the amount of open space available for passive and some active recreation.

Environmental Justice

Construction impacts are temporary in nature, but they can range from annoying to detrimental for those living near a construction site. None of the block groups immediately surrounding the two reservoir facilities and trucking routes are defined as minority or low-income areas (US Census, 2000). Therefore, little or no adverse impacts to low-income and minority communities would be expected.

Protection of Children

In the short term, because construction sites can be enticing to children, construction activity could present an unavoidable increased safety risk. Barriers and “no trespassing” signs would be placed around construction sites to deter children from playing in these areas. All construction vehicles, equipment and materials would be stored in fenced areas and secured when not in use. During construction, safety measures stated in 29 CFR 1926, Safety and

Health Regulations for Construction, and other applicable regulations and guidance would be followed to protect the health and safety of residents surrounding the treatment facilities, as well as construction workers.

It is our overall finding that Alternative B will pose no adverse impact to socioeconomic and environmental justice.

It is our finding that Alternative B would have no impact on socioeconomic and environmental justice issues.

Alternative C—Thickening and Piping to Blue Plains AWWTP

Economic Development

Alternative C has the highest construction cost and will result in higher, but still relatively minor beneficial effects on the local and regional economy. In particular, business volume of regional suppliers of construction-related goods and services, as well as local convenience businesses serving construction workers (over a much larger area than the other alternatives) would increase during the construction phase.

However, as described under Alternative A, due to the sheer size of economic activity within the MWCOG region and the District of Columbia, the project would be unlikely to have any appreciable economic impact upon the regional economy. The cost of construction for Alternative C ($165.1 million) would represent 4.5 percent of the total value of commercial construction starts in the region during 2001-2002 ($3.7 billion).

One sector would be affected only by Alternative C, however. Because this project would be one of the largest directional drilling construction projects in the nation, it has the potential to monopolize the regional directional drilling equipment and contractors for an extended period of time, with beneficial effects to those contractors but adverse effects to other pipeline projects. Alternative C could adversely affect scheduling and could increase the cost of other pipeline projects nationally. The impact cannot be quantified without detailed study, but significant delays to other pipeline projects are theoretically possible. In addition to directly affecting other pipeline construction projects, this could result in short-term, indirect economic effects from delays in users' access to natural gas, oil, water supply and wastewater removal in areas where such pipeline projects are planned.

Alternative C would be expected to generate about 450 FTE construction jobs. With the large regional construction workforce that exists within commuting distance of the work site (over 209,000 in 2002), there would be no need for short-term employees to move into the area for the duration.

After construction, the pipeline and residuals processing would generate only about 2.33 FTE permanent jobs and will require operations and maintenance expenditures of approximately $2 million each year, more than Alternative A but still minor in comparison to annual aggregate federal spending within the MWCOG region each year ($87.5 billion).

Demographics

Since the project sites themselves are located within the boundaries of the water utility properties, and there would be no permanent employees relocating to the area, no population change is expected.

Housing

As mentioned above, the projects themselves are limited to the confines of the Washington Aqueduct, NPS, or DC-WASA property, thereby eliminating any chance of housing units being removed or altered. Little or no need for temporary housing for construction workers would be anticipated, because construction workers would commute daily to the work site from within the surrounding region. Directional drilling contractors based elsewhere may bring in some equipment operators from outside the region, who would require temporary housing, but there is a sufficient supply of hotels/motels and rental housing within commuting distance in the region to accommodate them. (Due to the cost of close-in rental housing, however, their commutes could be an hour or more.) With the minimal increase in long-term employment, no appreciable long-term effect on the local housing market would be expected.

Quality of Life

Law Enforcement, Fire, and Medical Services

No appreciable adverse effect on local public safety resources would be expected. Due to heightened security conditions post September 11th, a security contingency plan may be needed during the construction period. The peak workload of 450 construction workers would generate only minimal additional demand for services. Up to 0.22 additional police FTEs, 0.18 additional fire fighter FTEs, and four additional EMS calls annually are estimated, for the duration of the construction period. Compared to the additional workload placed on District of Columbia resources during large public events on the National Mall and elsewhere in the city, this level of increased demand would be minimal.

Schools

No adverse effect on local schools would be expected. There would be no population-driven change in school enrollments. Since the pipeline passes by several schools along its projected route, however, increased noise and construction traffic could present short-term nuisances if any of the aboveground setup locations were near a school. Such disturbances are discussed in greater detail in the Noise and Traffic sections.

Shops and Services

No long-term increase in demand for shops and services would be expected from this alternative. It should be noted, however, that the pipeline route passes through several waterfront areas, with moderate to heavy commercial activity. Some disruption would be expected, but should not be significant, due to the relatively small areas of disturbance (similar to other utility projects).

Recreation

The pipeline would cross several parks, including but not limited to, East Potomac Park, Rock Creek Park, and the Chesapeake and Ohio National Canal Park. Additionally, several parks are within close proximity to the pipeline route. Increased noise and construction traffic, as well as possible restrictions on park use in certain areas would occur.

The directionally drilled construction of the pipeline would not be expected to interrupt marine and water-based recreational traffic where it passes under on the Anacostia River, but some disruption could occur at setup locations (“rig side” drilling or “pipe side” pipe pulling operations) along its shores.

Environmental Justice

Construction impacts are temporary in nature, but they can range from annoying to detrimental for those living near a construction site. None of the block groups immediately surrounding the two reservoir facilities are defined as minority or low-income areas (US Census, 2000). Two out of ten block groups crossed by the pipeline route are low-income areas, with one of the two also being a minority community. Overall, however, most of the pipeline route avoids low-income and minority areas.

The area (1-mile radius) surrounding the Blue Plains AWWTP (where the pipeline would end and a residuals processing plant would be built, which includes the area where trucks would enter and exit from the Anacostia Freeway) does meet the criteria for both a minority population and a poverty area.

However, since the construction site is in the middle of the Blue Plains AWWTP industrial facility, and Blue Plains is separated from adjacent housing areas by the Anacostia Freeway, there is very little chance that the construction project would result in direct adverse impacts to the low-income and minority population within the surrounding area. This project would not cause hazardous air emissions or surface water discharges, which are the only factors that might affect area residents separated from the site by a major road. The pipeline alternative would result in increased truck traffic entering and exiting Blue Plains AWWTP from the Anacostia Freeway, which is not likely to result in appreciable impacts to residents of the area compared to the existing traffic on that highway (see Transportation section).

Therefore, no disproportionately adverse impacts to low-income and minority communities would be expected.

Protection of Children

The impacts are similar to the previous alternatives.

It is our finding that Alternative C would have no impact on socioeconomic and environmental justice issues.

Alternative D—No Action Alternative

The No Action alternative would not effect local population or economic activity in the ROI. To the extent that continued discharge of sediments into the river affects fish populations or other environmental resources, the value of the river as a recreational resource could be adversely affected over time. (See the Biological Resources section for more information.)

It is our finding that Alternative D would have no impact on socioeconomic and environmental justice issues.

Alternative E—Dewatering at East Dalecarlia Processing Site and Disposal by Trucking

Siting the residuals facilities near the reservoir and Sibley Memorial Hospital, and using either Little Falls Road or a newly-constructed road to access Dalecarlia Parkway, would be similar to the effects of Alternative B—Dewatering at Northwest Dalecarlia Processing Site and Disposal by Trucking (see discussion of that alternative for additional details).

Economic Development

Like the other alternatives, Alternative E is unlikely to have any appreciable economic impact upon the regional economy. The cost of constructing and operating the residuals processing facility would be similar to Alternative B. If a new access road is constructed, instead of using Little Falls Road, costs and construction jobs would increase but would remain below the cost of construction for Alternative C—Thickening and Piping to Blue Plains AWWTP. After construction, residuals processing and contract hauling to a commercial landfill would generate the same number of jobs and expenditures as Alternative B.

Demographics

As for Alternative B, no population change would be expected.

Housing

As for Alternative B, construction employment would not expected to generate any demand for short-term housing in the immediate area.

Quality of Life

Construction of the residuals treatment facility near Sibley Memorial Hospital would place it further from the Capital Crescent Trail and residences adjacent to the Dalecarlia treatment plant property, reducing the likelihood of temporary disturbance during construction to trail users and those residents in comparison to Alternative B. However, the view of the reservoir from the Capital Crescent Trail and from the other residences that adjoin the reservoir could be permanently altered, but to a lesser degree than for Alternative A—Dewatering at Northwest Dalecarlia Processing Site and Disposal by Monofill. Truck traffic would (but decrease along others in comparison to Alternative B) but analysis shows level of service, noise, safety, etc. would not be affected. (See the Noise, Traffic, and Aesthetics and Visual Resources sections for more detailed discussion of these impacts.)

Law Enforcement, Fire, and Medical Services

Similar to Alternative B, no appreciable adverse effect on local public safety resources would be expected.

Schools

Similar to Alternative B, no impact on schools or child safety would be expected.

Shops and Services

Similar to Alternative B, no long-term demand for shops and services would be expected to arise from the project and construction would not be expected to affect access to local businesses. Local convenience businesses (retail, fast food, gas stations) would benefit from the additional construction workers in the area.

Recreation

An adverse but not significant impact to nearby recreation facilities would result from the proposed action. Construction of the residuals processing facility near Sibley Memorial Hospital would cause construction nuisances and noise adjacent to the Capital Crescent Trail, but to a lesser degree than for Alternative B where the construction site would be much closer to the trail. The entire property surrounding the reservoir is fenced off from the trail and Spring Valley Park. Although people who use areas outside the fence for passive recreation could experience nuisance effects during construction, and their view of the reservoir would be permanently altered, Alternative E will not directly reduce the amount of open space available for passive and some active recreation.

Environmental Justice

None of the block groups immediately surrounding the processing facility site near Sibley Memorial Hospital, the reservoir, and the associated trucking routes are defined as minority or low-income areas (US Census, 2000). Therefore, little or no adverse impacts to low-income and minority communities would be expected.

Protection of Children

In the short term, because construction sites can be enticing to children, construction activity could present be an unavoidable increased safety risk. Barriers and “no trespassing” signs would be placed around construction sites to deter children from playing in these areas. All construction vehicles, equipment and materials would be stored in fenced areas and secured when not in use. During construction, safety measures stated in 29 CFR 1926, Safety and Health Regulations for Construction, and other applicable regulations and guidance would be followed to protect the health and safety of residents surrounding the treatment facilities, as well as construction workers.

It is our finding that Alternative E would have no impact on socioeconomic and environmental justice issues.

Forebay Residuals Treatment Option

The method by which residuals are removed from the Forebay has no additional socioeconomic or environmental justice impacts.

It is our finding that Forebay residuals treatment option would have no impact on socioeconomic and environmental justice issues.

4.14 Cost

4.14.1 Definition

The potential cost to the customers represented by the proposed alternatives takes into consideration both initial capital costs and long-term operational and maintenance costs.

4.14.2 Cost Significance Criteria

No Impact

An alternative has no impact on cost if its capital cost (in 2004 dollars) is below the $50,000,000.00 capital budget allocation for the residuals project.

No Significant Impact

An alternative has no significant impact on cost if its capital cost (in 2004 dollars) is above the $50,000,000.00 capital budget allocation for the project but below amount equal to 30-percent over the budget allocation, or $65,000,000.00.

Significant Impact

An alternative has a significant impact on cost if its capital cost (in 2004 dollars) is above $65,000,000.00.

SOCIOECONOMIC AND ENVIRONMENTAL JUSTICE

- CENSUS 2000 DATA SUMMARY
- SOCIOECONOMIC CALCULATIONS

Census 2000 Demographic Data for Dalecarlia Reservoir and Surrounding Jurisdictions

Demographics (2000)	ROI	DC District of Columbia	MD Frederick County	MD Montgomery County	MD Prince George's County	VA Arlington County	VA City of Alexandria	VA City of Fairfax	VA City of Falls Church	VA City of Manassas	VA City of Manassas Park	VA Fairfax County	VA Loudoun County	VA Prince William County
Total Population 1990	3,923,600	537,218	240,346	989,655	729,268	170,936	111,183	19,622	9,578	27,957	6,797	818,584	86,129	215,686
Total Population 2000	4,450,300	572,059	195,277	873,341	801,515	189,453	128,283	21,498	10,377	35,135	10,290	969,749	169,599	280,813
Percent Change 1990-2000	13.42	6.49	30.00	15.40	9.90	10.80	15.40	9.60	8.30	25.68	51.40	18.50	96.90	30.20
Persons per Square Mile	1,474	9,317	295	1,762	1,651	7,323	8,451	3,407	5,215	3,537	4,129	2,455	326	831
Projected Growth 2015	5,392,900	588,000	260,000	975,000	886,100	207,200	138,700	22,800	10,800	37,600	15,500	1,155,600	371,200	369,200
Percent Change 2000-2015	21.18	2.79	33.14	11.64	10.55	9.37	8.12	6.06	4.08	7.02	50.63	19.16	118.87	31.48
Median Age (years)	34.90	34.60	35.60	36.80	33.30	34.00	34.40	37.00	39.70	31.30	30.30	37.00	33.60	31.90
Average household size	2.59	2.16	2.72	2.66	2.74	2.15	2.04	2.61	2.31	2.88	3.16	2.74	2.82	2.94
Average family size	NA	3.07	3.16	3.19	3.25	2.96	2.87	3.07	3.01	3.39	3.47	3.20	3.24	3.32
Veterans (% of civilians)	12.00	9.80	14.30	9.90	13.40	10.00	11.30	13.10	14.70	14.20	12.60	13.50	13.30	18.50

Environmental Justice Demographics (2000)	ROI	DC District of Columbia	MD Frederick County	MD Montgomery County	MD Prince George's County	VA Arlington County	VA City of Alexandria	VA City of Fairfax	VA City of Falls Church	VA City of Manassas	VA City of Manassas Park	VA Fairfax County	VA Loudoun County	VA Prince William County
White (%)	57.00	30.78	89.33	64.78	27.04	68.94	59.79	72.91	84.97	72.10	72.80	69.91	82.79	68.93
Black or African American (%)	28.20	60.00	6.40	15.10	62.70	9.30	22.50	5.10	3.30	12.90	11.20	8.60	6.90	18.80
American Indian & Alaska Native (%)	0.30	0.30	0.21	0.29	0.35	0.35	0.28	0.34	0.24	0.40	0.40	0.26	0.21	0.39
Asian, Hawaiian and Other Pacific Islander (%)	7.60	2.70	1.70	11.30	3.90	8.60	5.70	12.20	6.50	6.90	4.20	13.00	5.30	3.80
Some other race (%)	4.00	3.84	0.92	5.00	3.38	8.33	7.38	6.17	2.52	7.90	8.10	4.54	2.26	4.35
Two or more races (%)	3.00	2.35	1.47	3.45	2.61	4.34	4.27	3.26	2.43	3.30	3.30	3.65	2.44	3.62
Hispanic Origin (%)	9.70	7.90	2.40	11.50	7.10	18.60	14.70	13.60	8.40	15.10	15.00	11.00	5.90	9.70
Poverty Rate (%)	7.60	16.90	4.80	4.20	5.80	7.10	7.10	6.00	5.20	8.00	5.20	3.50	3.10	3.20

Dalecarlia Reservoir and Treatment Plant, adjoining block groups (1-mile radius)

GEO_ID	SUMLEVEL	GEO_NAME	P003002	P003003	P003004	P003005	P003006	P003007	P003008	P003009	
Geography Identifier	Geographic Summary Level	Geography	Total population: Population of one race	Total population: Population of one race; White alone	Total population: Population of one race; Black or African American alone	Total population: Population of one race; American Indian and Alaska Native alone	Total population: Population of one race; Asian alone	Total population: Population of one race; Native Hawaiian and Other Pacific Islander alone	Total population: Population of one race; Some other race alone	Total population: Population of two or more races	Total population
10000US110010009017002	100	Block 7002, Block Group 7, Census Tract 9.01, District of Columbia, District of Columbia	147	125	3	0	18	0	1	0	147
10000US110010009017004	100	Block 7004, Block Group 7, Census Tract 9.01, District of Columbia, District of Columbia	65	62	3	0	0	0	0	2	67
10000US110010009017006	100	Block 7006, Block Group 7, Census Tract 9.01, District of Columbia, District of Columbia	147	132	6	0	8	0	1	0	147
10000US110010009017007	100	Block 7007, Block Group 7, Census Tract 9.01, District of Columbia, District of Columbia	0	0	0	0	0	0	0	0	0
10000US110010009017009	100	Block 7009, Block Group 7, Census Tract 9.01, District of Columbia, District of Columbia	0	0	0	0	0	0	0	0	0
10000US110010009024000	100	Block 4000, Block Group 4, Census Tract 9.02, District of Columbia, District of Columbia	0	0	0	0	0	0	0	0	0
10000US240317057023001	100	Block 3001, Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	238	230	1	0	6	0	1	0	238
10000US240317057023014	100	Block 3014, Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	42	42	0	0	0	0	0	0	42
10000US240317057023015	100	Block 3015, Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	76	67	2	0	5	0	2	0	76
10000US240317057023017	100	Block 3017, Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	51	51	0	0	0	0	0	0	51
10000US240317057023018	100	Block 3018, Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	73	70	0	0	2	0	1	0	73
10000US240317057023019	100	Block 3019, Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	0	0	0	0	0	0	0	0	0
10000US240317057023020	100	Block 3020, Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	0	0	0	0	0	0	0	0	0
10000US240317057023021	100	Block 3021, Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	68	67	0	0	1	0	0	0	68
10000US240317058003040	100	Block 3040, Block Group 3, Census Tract 7058, Montgomery County, Maryland	0	0	0	0	0	0	0	0	0
			907	846	15	0	40	0	6	2	909
				93.07%	1.65%	0.00%	4.40%	0.00%	0.66%	0.22%	100.00%

GEO_ID	SUMLEVEL	GEO_NAME	P053001	P087001	P087002	
Geography Identifier	Geographic Summary Level	Geography	Households: Median household income in 1999	Population for whom poverty status is determined: Total	Population for whom poverty status is determined: Income in 1999 below poverty level	% Below Poverty
15000US110010009011	150	Block Group 1, Census Tract 9.01, District of Columbia	100874	653	79	12.10%
15000US110010009012	150	Block Group 2, Census Tract 9.01, District of Columbia	200001	488	6	1.23%
15000US110010009016	150	Block Group 6, Census Tract 9.01, District of Columbia	153177	1336	30	2.25%
15000US110010009017	150	Block Group 7, Census Tract 9.01, District of Columbia	194525	1447	59	4.08%
15000US110010009023	150	Block Group 3, Census Tract 9.02, District of Columbia	149451	701	25	3.57%
15000US110010009024	150	Block Group 4, Census Tract 9.02, District of Columbia	105619	1266	37	2.92%
15000US240317057021	150	Block Group 1, Census Tract 7057.02, Montgomery County, Maryland	136009	1092	22	2.01%
15000US240317057022	150	Block Group 2, Census Tract 7057.02, Montgomery County, Maryland	96632	2033	22	1.08%
15000US240317057023	150	Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	198091	1429	26	1.82%
15000US240317058001	150	Block Group 1, Census Tract 7058, Montgomery County, Maryland	113714	2421	51	2.11%
15000US240317058002	150	Block Group 2, Census Tract 7058, Montgomery County, Maryland	145121	2485	52	2.09%
15000US240317058003	150	Block Group 3, Census Tract 7058, Montgomery County, Maryland	124253	872	6	0.69%
		Weighted Average	117552.0428	16223	415	2.56%

GEO_ID	SUMLEVEL	GEO_NAME	P007001	P007010	
Geography Identifier	Geographic Summary Level	Geography	Total population: Total	Total population: Hispanic or Latino	Percentage
15000US110010009011	150	Block Group 1, Census Tract 9.01, District of Columbia	653	63	9.65%
15000US110010009012	150	Block Group 2, Census Tract 9.01, District of Columbia	3778	190	5.03%
15000US110010009016	150	Block Group 6, Census Tract 9.01, District of Columbia	1336	69	5.16%
15000US110010009017	150	Block Group 7, Census Tract 9.01, District of Columbia	1447	66	4.56%
15000US110010009023	150	Block Group 3, Census Tract 9.02, District of Columbia	701	64	9.13%
15000US110010009024	150	Block Group 4, Census Tract 9.02, District of Columbia	1266	53	4.19%
15000US240317057021	150	Block Group 1, Census Tract 7057.02, Montgomery County, Maryland	1098	63	5.74%
15000US240317057022	150	Block Group 2, Census Tract 7057.02, Montgomery County, Maryland	2033	90	4.43%
15000US240317057023	150	Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	1429	68	4.76%
15000US240317058001	150	Block Group 1, Census Tract 7058, Montgomery County, Maryland	2421	132	5.45%
15000US240317058002	150	Block Group 2, Census Tract 7058, Montgomery County, Maryland	2485	60	2.41%
15000US240317058003	150	Block Group 3, Census Tract 7058, Montgomery County, Maryland	872	5	0.57%
		TOTAL	19519	923	4.73%

Georgetown Reservoir, Adjoining Block Groups

GEO_NAME	P006001	P006002	P006003	P006004	P006005	P006006	P006007	P006008	P007001	P007010	P053001	P087001	P087002
Geography	Total population: Total	Total population: White alone	Total population: Black or African American alone	Total population: American Indian and Alaska Native alone	Total population: Asian alone	Total population: Native Hawaiian and Other Pacific Islander alone	Total population: Some other race alone	Total population: Two or more races	Total population: Total	Total population: Hispanic or Latino	Households: Median household income in 1999	Population for whom poverty status is determined: Total	Population for whom poverty status is determined: Income in 1999 below poverty level
Block Group 4, Census Tract 8.01, District of Columbia, District of Columbia	1458	1128	155	8	152	0	0	15	1458	62	61944	712	60
Block Group 2, Census Tract 8.02, District of Columbia, District of Columbia	1067	970	18	3	64	0	0	12	1067	27	111163	1067	148
Block Group 3, Census Tract 8.02, District of Columbia, District of Columbia	1739	1478	54	0	164	0	15	28	1739	133	61801	1739	229
	4264	3576	227	11	380	0	15	55	4264	222	234908	3518	437
	100.00%	83.86%	5.32%	0.26%	8.91%	0.00%	0.35%	1.29%	100.00%	5.21%	$78,302.67		12.42%

Pipeline route, block groups

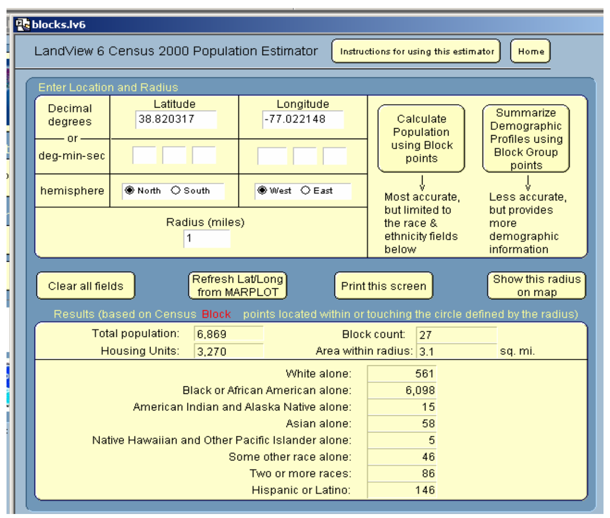
GEO_ID	SUMLEVEL	GEO_NAME	P006001	P006002	P006003	P006004	P006005	P006006	P006007	P006008	P007010	P053001	P087001	P087002	
Geography Identifier	Geographic Summary Level	Geography	Total population: Total	Total population: White alone	Total population: Black or African American alone	Total population: American Indian and Alaska Native alone	Total population: Asian alone	Total population: Native Hawaiian and Other Pacific Islander alone	Total population: Some other race alone	Total population: Two or more races	Total population: Hispanic or Latino	Households: Median household income in 1999	Population for whom poverty status is determined: Total	Population for whom poverty status is determined: Income in 1999 below poverty level	Poverty by block
15000US110010001004	150	Block Group 4, Census Tract 1, District of Columbia, District of Columbia	920	832	50	0	29	0	0	9	49	101502	920	57	6.20%
15000US110010002024	150	Block Group 4, Census Tract 2.02, District of Columbia, District of Columbia	1038	969	15	0	32	0	5	17	81	84342	1038	345	33.24%
				93%	1%	0%	3%	0%	0%	2%	8%				
15000US110010008014	150	Block Group 4, Census Tract 8.01, District of Columbia, District of Columbia	1458	1128	155	8	152	0	0	15	62	61944	712	60	8.43%
15000US110010008023	150	Block Group 3, Census Tract 8.02, District of Columbia, District of Columbia	1739	1478	54	0	164	0	15	28	133	61801	1739	229	13.17%
15000US110010009017	150	Block Group 7, Census Tract 9.01, District of Columbia, District of Columbia	1447	1314	41	0	60	0	0	32	66	194525	1447	59	4.08%
15000US110010009024	150	Block Group 4, Census Tract 9.02, District of Columbia, District of Columbia	1266	1140	48	0	29	0	40	9	53	105619	1266	37	2.92%
15000US110010062021	150	Block Group 1, Census Tract 62.02, District of Columbia, District of Columbia	0	0	0	0	0	0	0	0	0	0	0	0	NA
15000US110010073011	150	Block Group 1, Census Tract 73.01, District of Columbia, District of Columbia	5234	3034	1593	44	198	17	184	164	461	49122	4631	118	2.55%
15000US110010073081	150	Block Group 1, Census Tract 73.08, District of Columbia, District of Columbia	382	40	315	0	0	0	9	18	18	0	382	345	90.31%
				10%	82%	0%	0%	0%	2%	5%	5%				
15000US240317057023	150	Block Group 3, Census Tract 7057.02, Montgomery County, Maryland	1429	1344	0	7	32	0	40	6	68	198091	1429	26	1.82%
			14913	11280.03824	2271.839058	59	696.0308285	17	293.0283772	298.0634981	991.1251551	1334083043	13564	1276	
				75.64%	15.23%	0.40%	4.67%	0.11%	1.96%	2.00%	6.65%	$89,457.72		9.41%	
				0.8203125											
				0.014450867											

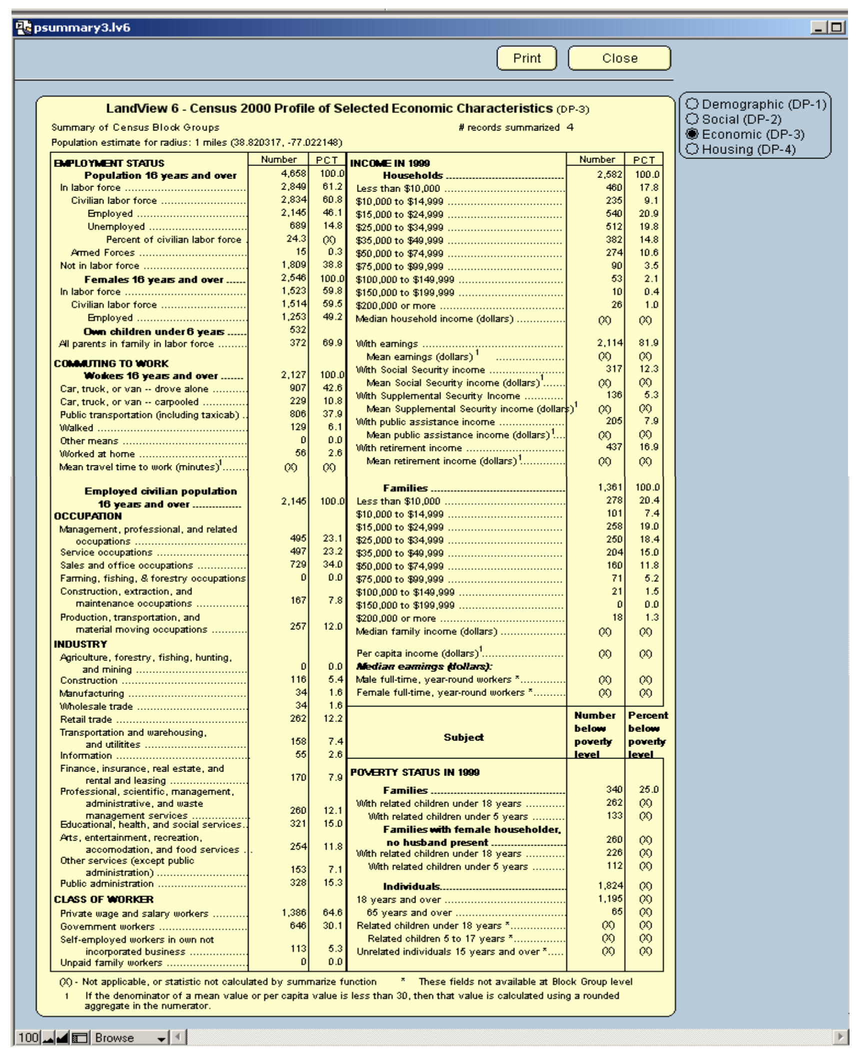
End of Pipeline is at West 77deg 1min 19.72sec
North 38deg 49min 13.14sec

Pipeline terminal point (processing building) at Blue Plains, adjoining block groups (1-mile radius).

Truck exit onto Anacostia Freeway is about 500 ft N and 1000 ft E of that.

Poverty rate for individuals not calculated.
Estimate (based on total population):
27%





LandView 6 - Census 2000 Profile of Selected Economic Characteristics (DP-3)

Summary of Census Block Groups   # records summarized 4

Population estimate for radius: 1 miles (38.820317, -77.022148)

EMPLOYMENT STATUS	Number	PCT
Population 16 years and over	4,658	100.0
In labor force	2,849	61.2
Civilian labor force	2,834	60.8
Employed	2,145	46.1
Unemployed	689	14.8
Percent of civilian labor force	24.3	(X)
Armed Forces	15	0.3
Not in labor force	1,809	38.8
Females 16 years and over	2,546	100.0
In labor force	1,523	59.8
Civilian labor force	1,514	59.5
Employed	1,253	49.2
Own children under 6 years	532	
All parents in family in labor force	372	69.9
COMMUTING TO WORK		
Workers 16 years and over	2,127	100.0
Car, truck, or van -- drove alone	907	42.6
Car, truck, or van -- carpooled	229	10.8
Public transportation (including taxicab)	806	37.9
Walked	129	6.1
Other means	0	0.0
Worked at home	56	2.6
Mean travel time to work (minutes)[1]	(X)	(X)
Employed civilian population 16 years and over	2,145	100.0
OCCUPATION		
Management, professional, and related occupations	495	23.1
Service occupations	497	23.2
Sales and office occupations	729	34.0
Farming, fishing, & forestry occupations	0	0.0
Construction, extraction, and maintenance occupations	167	7.8
Production, transportation, and material moving occupations	257	12.0
INDUSTRY		
Agriculture, forestry, fishing, hunting, and mining	0	0.0
Construction	116	5.4
Manufacturing	34	1.6
Wholesale trade	34	1.6
Retail trade	262	12.2
Transportation and warehousing, and utilitites	158	7.4
Information	55	2.6
Finance, insurance, real estate, and rental and leasing	170	7.9
Professional, scientific, management, administrative, and waste management services	260	12.1
Educational, health, and social services	321	15.0
Arts, entertainment, recreation, accomodation, and food services	254	11.8
Other services (except public administration)	153	7.1
Public administration	328	15.3
CLASS OF WORKER		
Private wage and salary workers	1,386	64.6
Government workers	646	30.1
Self-employed workers in own not incorporated business	113	5.3
Unpaid family workers	0	0.0

INCOME IN 1999	Number	PCT
Households	2,582	100.0
Less than $10,000	460	17.8
$10,000 to $14,999	235	9.1
$15,000 to $24,999	540	20.9
$25,000 to $34,999	512	19.8
$35,000 to $49,999	382	14.8
$50,000 to $74,999	274	10.6
$75,000 to $99,999	90	3.5
$100,000 to $149,999	53	2.1
$150,000 to $199,999	10	0.4
$200,000 or more	26	1.0
Median household income (dollars)	(X)	(X)
With earnings	2,114	81.9
Mean earnings (dollars)[1]	(X)	(X)
With Social Security income	317	12.3
Mean Social Security income (dollars)[1]	(X)	(X)
With Supplemental Security Income	136	5.3
Mean Supplemental Security income (dollars)[1]	(X)	(X)
With public assistance income	205	7.9
Mean public assistance income (dollars)[1]	(X)	(X)
With retirement income	437	16.9
Mean retirement income (dollars)[1]	(X)	(X)
Families	1,361	100.0
Less than $10,000	278	20.4
$10,000 to $14,999	101	7.4
$15,000 to $24,999	258	19.0
$25,000 to $34,999	250	18.4
$35,000 to $49,999	204	15.0
$50,000 to $74,999	160	11.8
$75,000 to $99,999	71	5.2
$100,000 to $149,999	21	1.5
$150,000 to $199,999	0	0.0
$200,000 or more	18	1.3
Median family income (dollars)	(X)	(X)
Per capita income (dollars)[1]	(X)	(X)
Median earnings (dollars):		
Male full-time, year-round workers *	(X)	(X)
Female full-time, year-round workers *	(X)	(X)

Subject	Number below poverty level	Percent below poverty level
POVERTY STATUS IN 1999		
Families	340	25.0
With related children under 18 years	262	(X)
With related children under 5 years	133	(X)
Families with female householder, no husband present	260	(X)
With related children under 18 years	226	(X)
With related children under 5 years	112	(X)
Individuals	1,824	(X)
18 years and over	1,195	(X)
65 years and over	65	(X)
Related children under 18 years *	(X)	(X)
Related children 5 to 17 years *	(X)	(X)
Unrelated individuals 15 years and over *	(X)	(X)

(X) - Not applicable, or statistic not calculated by summarize function   * These fields not available at Block Group level

1 If the denominator of a mean value or per capita value is less than 30, then that value is calculated using a rounded aggregate in the numerator.

Sensitive Receptors

Dalecarlia Reservoir	
Name	**Type**
Wesley Seminary	School
Crescent Trail	Park
Spring Valley Park	Park
Chesapeake and Ohio Canal National Park	Reserve
Friendship Recreation Center	Recreation
Little Falls	River
Chesapeake Canal	River

Georgetown Reservoir	
Name	**Type**
Hardy Middle School	School
Georgetown Day School	School
Georgetown University	School
Harrison School	School
Woodmont School	School
Mt. Vernon Junior College & Seminary	School
Conduit Road School	School
Hardy Playground	Park
Reservoir Playground	Park
Chesapeake and Ohio Canal National Park	Reserve
Hardy Recreation Center	Recreation
Riverside Hospital	Hospital
Georgetown University Hospital	Hospital
Engine Company 29	Fire

Pipeline	
Name	**Type**
Key Elementary School	School
Prospect Learning Center	School
Hyde Elementary School	School
Saint Stevens School	School
Saint Stephens School	School
Stevens Junior High School	School
Francis Junior High School	School
George Washington University	School
Schools Without Walls Senior High School	School
Jefferson Junior High School	School
Hawthorne High School	School
Leckie Elementary School	School
Patterson Elementary School	School
National Mall	Feature
Reflecting Pool	Feature
East Potomac Park	Park
International Athletic Park	Park
Chesapeake and Ohio Canal National Park	Reserve
Palisades Park and Recreation Center	Recreation
The Potomac Gorge	Park
Georgetown Playground and Recreation Center	Park
Georgetown Waterfront Park	Park
Rock Creek Park	Park
James Monroe Park	Park
Lincoln Memorial	Park
West Potomac Park	Park
Jefferson Memorial	Park
Potomac River	River
Rock Creek	River
Anacostia River	River

Economic Development (2000)	ROI	DC District of Columbia	MD Frederick County	MD Montgomery County	MD Prince George's County	VA Arlington County	VA City of Alexandria	VA City of Fairfax	VA City of Falls Church	VA City of Manassas	VA City of Manassas Park	VA Fairfax County	VA Loudoun County	VA Prince William County
Total labor force	2,360,346	298,225	107,151	477,123	431,120	120,803	80,949	12,361	6,072	19,118	5,672	548,812	95,686	157,254
Unemployment (%)	3.7	6.8	2.2	2.2	4.1	2	2.3	1.6	2.1	2.8	1.7	1.9	1.6	2.2
At-place employment (2002)	2,553,077	663,100	81,828	450,197	305,318	151,376	88,065	17,913	14,096	20,095	3,721	523,431	96,739	84,521
Income	$42,726	$39,970	$32,134	$49,107	$30,340	$49,683	$48,427	$67,642	$74,924	$60,409	$60,794	$51,596	$39,055	$30,602

At-place Employment by Industrial Group	PMSA Total (2002)
Manufacturing	65,521
Natural Resources & Mining	1,434
Construction	153,589
Trade, Transportation and Utilities	355,634
Information	114,892
Financial Activities	145,168
Professional and Business Services	549,145
Educational & Health Services	261,520
Leisure & Hospitality	212,515
Other Services	139,600
Federal Government	321,382
Local Government	183,963
State Government	75,209
Other/Unclassifiable	1,774
Total	**2,581,346**

MWCOG region, 2002	million			
office space	$843	$ 843,000,000	0.0%	7.5 million square feet
educational and medical space	$334	$ 334,000,000	0.0%	2.1 million square feet
other commercial space	$468	$ 468,000,000	0.0%	1.8 million square feet
		$ 1,645,000,000	0.0%	

Source: MWCOG Commercial Construction Indicators

Housing	Total	Occupied	Vacancy Rate
MWCOG	1,684,215	1,607,261	4.6%
District of Columbia	274,845	248,338	9.6%

Source: MWCOG "Our Changing Reqion, Census 2000"

Socieconomic Calculations:

	Estimated Construction cost ($2004)	% of 2001-02 regional construction starts**	Estimated Construction Labor (FTEs)*	O&M Cost (Annual)	Estimated O&M Labor (FTEs)
Alternative A-Dalecarlia Monofill	$56,894,000	1.6%	340	$877,000	3.333
Alternative B-Dedicated Pipeline to Blue Plains	$145,197,000	4.0%	867	$1,998,000	2.333
Alternative C-Onsite Processing with Hauling	$50,197,000	1.4%	300	$1,923,000	2.333

based on:

*Labor-Avg construction income, DC-Mont-Arl-Ffx, 2002: $55,262

and national average labor/materials breakdown for nonbuilding facilities

** Value of construction starts in region, 2001-2002: $3,662,187,091

Additional Public Safety Resources Needed (during construction period)

	Estimated construction workers (FTEs)	Police (FTEs)	Fire fighter (FTEs)	Fire fighting vehicles	EMS personnel (FTEs)	EMS vehicles	Annual EMS calls
Alternative A-Dalecarlia Monofill	340	0.17	0.14	0.02	0.01	0.003	3.10
Alternative B-Pipeline to Blue Plains	867	0.43	0.36	0.04	0.03	0.01	7.91
Alternative C-Onsite Processing with Hauling	300	0.15	0.12	0.02	0.01	0.003	2.74

Nonresidential Workforce Planning Factor	Resource
0.5 per 1,000 pop	Police
0.4 per 1,000 pop	Fire fighter FTEs
0.1 per 1,000 pop	Fire fighting vehicles
1.0 per 30,000 pop	EMS personnel FTEs
0.3 per 30,000 pop	EMS vehicles
9.1 per 1,000 pop	Annual EMS calls

Source: Burchell, Robert W., David Listokin, et al. *Development Impact Assessment Handbook.* Washington, DC: the Urban Land Institute, 1994.

Average Construction Labor and Materials Breakdown	Labor	Materials
TOTAL CONSTRUCTION ACTIVITY	34.2%	57.8%
NEW CONSTRUCTION	30.6%	61.3%
Hotels & Motels	29.2%	63.8%
Industrial Buildings	38.0%	56.8%
Office Buildings	33.8%	61.3%
Garages & Service Stations	33.1%	59.0%
Stores & Restaurants	35.9%	61.9%
Amusement & Recreation Buildings	35.0%	60.5%
Local Transit Facilities	29.6%	63.0%
Other nonbuilding facilities	33.0%	60.6%

Source: US Army Corps of Engineers, Economic Impact Forecasting System (EIFS) model documentation (calculated %'s)

CA05N Personal income by major source and earnings by industry -- (thousands of dollars) http://www.bea.gov/bea/regional/reis/ downloaded 10/20/04

Washington-Baltimore-Northern Virginia, DC-MD-VA-WV (CSA)			Washington-Baltimore-Northern Virginia, DC-MD-VA-WV (CSA)		calc: Avg earnings by industry	District of Columbia		calc: Avg earnings by industry	Montgomery		calc: Avg earnings by industry	Arlington		calc: Avg earnings by industry	Fairfax, Fairfax City + Falls Church		calc: Avg earnings by industry
	LineCode	**LineTitle**	**2001**	**2002**		**2001**	**2002**		**2001**	**2002**		**2001**	**2002**		**2001**	**2002**	
(note: other income data deleted, not applicable)																	
89548	82	Nonfarm earnings	$257,315,870	$265,918,150		$52,644,199	$55,651,184		$31,014,607	$32,187,758		$13,572,015	$13,810,332		$43,733,909	$44,174,859	
89548	90	Private earnings	$192,812,940	$196,328,267		$31,637,300	$32,822,589		$24,679,471	$25,354,799		$8,555,573	$8,589,117		$37,964,084	$37,847,521	
89548	100	Forestry, fishing, related activities, and other 7/	(D)	(D)		(D)	(D)		$9,555	$9,562		$215	$221		$4,953	$4,905	
89548	101	Forestry and logging	(D)	(D)		$217	$224		$116	$120		$106	$109		$800	$815	
89548	102	Fishing, hunting, and trapping	(D)	(D)		$220	$226		$237	$243		$58	$59		(D)	(D)	
89548	103	Agriculture and forestry support activities	(D)	(D)		$466	$518		$9,202	$9,199		$51	$53		(D)	(D)	
89548	104	Other 7/	(D)	(D)		(D)	(D)		$0	$0		$0	$0		$0	$0	
89548	200	Mining	(D)	(D)		(D)	(D)		$13,574	$15,270		$1,263	$1,211		(D)	$198,398	
89548	201	Oil and gas extraction	(D)	(D)		$10,701	$10,489		$1,165	$1,061		$915	$827		$145,563	$131,380	
89548	202	Mining (except oil and gas)	(D)	(D)		$1,603	(D)		(D)	(D)		$332	$367		(D)	(D)	
89548	203	Support activities for mining	(D)	(D)		(D)	(D)		(D)	(D)		(L)	(L)		(D)	(D)	
89548	300	Utilities	(D)	(D)		(D)	(D)		$1,148,100	$1,244,490		(D)	(D)		(D)	(D)	
		<u>calc: average for DC, Montgomery, Arlington, Fairfax counties:</u>															
89548	**400**	**Construction**	**(D)**	**(D)**	**$55,262**	**$678,779**	**$767,305**	**$52,541**	**$1,888,595**	**$1,955,722**	**$52,015**	**$391,738**	**$335,759**	**$63,148**	**$2,513,835**	**$2,531,417**	**$58,009**
89548	401	Construction of buildings	(D)	(D)		$261,534	$303,379		$718,294	$758,255		$97,154	$107,532		(D)	(D)	
89548	402	Heavy and civil engineering construction	(D)	(D)		$154,923	$176,385		$159,211	$158,691		$76,495	$39,138		(D)	(D)	
89548	403	Specialty trade contractors	$8,687,037	$8,852,216		$262,322	$287,541		$1,011,090	$1,038,776		$218,089	$189,089		$1,241,050	$1,251,234	

(note: remaining industry data deleted, not applicable)

CA25N Total full-time and part-time employment by industry -- (number of jobs) http://www.bea.gov/bea/regional/reis/

			Washington-Baltimore-Northern Virginia, DC-MD-VA-WV (CSA)		District of Columbia		Montgomery		Arlington		Fairfax, Fairfax City + Falls Church	
	LineCode	LineTitle	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**	**2001**	**2002**
89548	10	Total employment	5,135,441	5,187,017	764,343	779,008	608,558	616,195	203,285	198,851	760,567	754,590
89548	20	Wage and salary employment	4,383,418	4,391,631	705,206	716,691	494,956	495,742	182,218	176,595	633,929	619,943
89548	40	Proprietors employment	752,023	795,386	59,137	62,317	113,602	120,453	21,067	22,256	126,638	134,647
89548	50	Farm proprietors employment	13,091	12,979	-	-	503	495	-	-	134	134
89548	60	Nonfarm proprietors employment 2/	738,932	782,407	59,137	62,317	113,099	119,958	21,067	22,256	126,504	134,513
89548	70	Farm employment	18,037	18,146	-	-	861	863	-	-	197	204
89548	80	Nonfarm employment	5,117,404	5,168,871	764,343	779,008	607,697	615,332	203,285	198,851	760,370	754,386
89548	90	Private employment	4,154,443	4,186,062	519,622	526,548	519,438	524,267	148,569	145,727	666,667	657,487
89548	100	Forestry, fishing, related activities, and other 3/	(D)	(D)	(D)	(D)	463	471	26	26	264	255
89548	200	Mining	(D)	(D)	(D)	(D)	701	720	166	165	(D)	681
89548	300	Utilities	(D)	(D)	(D)	(D)	1,139	1,389	(D)	(D)	(D)	(D)
89548	400	Construction	(D)	(D)	13,720	14,604	36,688	37,599	5,915	5,317	44,855	43,638
89548	500	Manufacturing	(D)	162511 E	3,884	(D)	20,273	18,812	(D)	(D)	(D)	13,091
89548	600	Wholesale trade	(D)	(D)	4,781	4,658	13,231	13,081	(D)	2,346	20,533	19,503
89548	700	Retail trade	488,323	487,576	20,271	20,240	61,445	59,878	10,488	10,427	71,561	71,480
89548	800	Transportation and warehousing	(D)	(D)	(D)	(D)	8,715	8,800	10,574	9,937	(D)	(D)
89548	900	Information	(D)	156986 E	(D)	28,260	21,803	19,834	10,524	9,493	52,724	41,706
89548	1000	Finance and insurance	197182 E	203512 E	21,840	22,058	31,700	32,534	3,849	3,957	31,299	32,918
89548	1100	Real estate and rental and leasing	175829 E	201256 E	17,097	18,596	29,282	33,054	6,963	7,701	30,712	35,734
89548	1200	Professional and technical services	630234 E	630,818	116,391	117,974	93,398	94,887	38,570	36,700	153,812	151,075
89548	1300	Management of companies and enterprises	35753 E	34395 E	2,582	2,486	1,906	1,888	3,636	3,306	16,597	16,064
89548	1400	Administrative and waste services	314194 E	308853 E	45,622	45,307	41,612	40,239	12,490	11,847	51,654	50,036
89548	1500	Educational services	133837 E	138616 E	42,218	42,471	11,781	12,426	5,035	6,246	12,006	12,157
89548	1600	Health care and social assistance	438249 E	455382 E	56,879	60,738	57,653	59,822	9,600	9,582	52,251	54,647
89548	1700	Arts, entertainment, and recreation	95449 E	99050 E	10,319	10,746	13,794	14,493	2,978	2,975	15,158	15,643
89548	1800	Accommodation and food services	(D)	304304 E	(D)	44,648	33,807	33,317	12,802	13,242	39,435	39,725
89548	1900	Other services, except public administration	313,598	320,801	66,084	67,088	40,047	41,023	11,435	11,414	41,702	42,900
89548	2000	Government and government enterprises	962,961	982,809	244,721	252,460	88,259	91,065	54,716	53,124	93,703	96,899
89548	2001	Federal, civilian	411,724	424,514	182,756	190,821	41,920	42,815	30,091	28,048	33,712	36,442
89548	2002	Military	107,207	103,694	22,991	22,324	6,673	6,128	14,610	14,906	7,064	6,341
89548	2010	State and local	444,030	454,601	38,974	39,315	39,666	42,122	10,015	10,170	52,927	54,116
89548	2011	State government	102154 E	103495 E	-	-	1,110	(D)	511	483	9,724	9,895
89548	2012	Local government	315563 E	(D)	38,974	39,315	38,556	(D)	9,504	9,687	43,203	44,221

Appendix I. Air Quality Memorandum

CENAB-WA-EN 9 MARCH 2007

MEMORANDUM FOR RECORD

SUBJECT: Analysis of Potential Impacts to Air Quality for System Improvements of the Dalecarlia WTP and McMillan WTP for Disinfection and pH Control

1. References: Air Emissions Inventory for Washington Aqueduct (2000); Final Environmental Impact Statement for a Proposed Water Treatment Residuals Management Process for the Washington Aqueduct, Washington Aqueduct (2003).

2. Based on the US EPA regulations derived from the Clean Air Act, the District of Columbia is in nonattainment with the National Ambient Air Quality Standards (NAAQS) for fine particulate matter (PM2.5) and for ozone. The area was determined according to the NAAQS regulations to be a moderate maintenance area for 8-hour ozone concentrations and a severe non-attainment area for one-hour ozone concentrations. In effect, the strictest designation establishes 25 tons/year as a *de minimis* threshold for both the emission of volatile organic compounds and nitrogen oxide compounds. Currently, based on an analysis and inventory of various emission sources at the both Washington Aqueduct water treatment plants, the emission of the regulated compounds is much less than the *de minimis* threshold. No *de minimis* threshold has been established for fine particulate matter, however a *de minimis* threshold of 100 tons/year was recommended by EPA for determining conformity for non-attainment areas.

3. The area is in attainment with the NAAQS for other pollutants including for lead, carbon monoxide, nitrogen dioxide, and sulfur dioxide. For each of these pollutants, the *de minimis* threshold was established as 100 tons/year, and emissions from both of the Washington Aqueduct water treatment plants are much less than the applicable thresholds.

4. The total estimated existing emissions from the Dalecarlia WTP and McMillan WTP are shown with anticipated direct and indirect emissions associated with the future residuals management process at the Dalecarlia WTP in Table 1. The emissions shown that are associated with the future residuals management process have been reduced by a factor of 2.4 from those presented in the Final Environmental Impact Statement for a Proposed Residuals Management Process for the Washington Aqueduct (Residuals EIS). The Residuals EIS presented an extremely conservative estimate in order to ensure the worst possible conditions were presented for indirect emissions from trucking; however this approach is not representative of a possible condition. The assumptions used for calculating emissions in the Residuals EIS were: 20 trucks per day; 6 days per week; 52 weeks per year; and 300 miles per trip. Although the number of trucks used in the estimate is possible for short durations, the actual average number of trucks over an entire year, even under worst-case conditions, is much fewer. A more realistic, although still conservative approach, would involve using estimated design year average numbers of truckloads: 10 trucks per day, 5 days per week; 52 weeks per year; and 300 miles per trip. This approach is a conservative representation of a possible worst-case year in which high demand for drinking water is coupled with turbid river conditions.

5. The anticipated emission of pollutants associated with various alternatives for the proposed action, and the no-action alternative, is shown in Table 2. The emissions considered regarding the different alternatives are associated with the deliveries of the respective chemicals needed for the different alternatives. The no-action alternative, or the existing condition, assumes a round-trip chlorine delivery distance of 180 miles for each plant. The alternatives involving delivery of aqueous hypochlorite and sodium chloride (for on-site generation of hypochlorite) are shown with an assumption of a round-trip delivery distance of 450 miles. For lime and caustic soda deliveries, 200 miles was assumed as the round-trip delivery distance. US EPA AP-42 emission factors for heavy duty diesel powered vehicles were used for estimating hydrocarbons, carbon monoxide and nitrogen oxides, similar to the approach taken in the Residuals EIS. For the estimation of sulfur dioxide emissions, 500 ppm sulfur content was assumed with a fuel efficiency of 30 miles per gallon and a specific gravity of 0.9 for the fuel. Estimates of PM 2.5 and PM 10 emissions were extrapolated from the Residuals EIS data derived from the US EPA Mobile 6 model runs by assuming a per mile emission equivalency.

6. A summation of the "worst case" combination of chemical delivery options for the proposed action yielding the highest amount of emissions of pollutants includes: bulk hypochlorite for disinfection, caustic alone for pH control, and sulfuric acid for pH control. The new emissions expected from this combination of features are shown in Table 3, along with the cumulative Washington Aqueduct emissions including the "worst case" combination of alternatives, and the *de minimis* regulatory thresholds. Implementation of the "worst case" combination of alternatives would not be expected to exceed the *de minimis* thresholds. Additionally, the cumulative emissions for Washington Aqueduct, including the "worst case" combination of alternatives, would not be expected to exceed the *de minimis* thresholds. Based on the emissions estimates, there are no significant impacts to air quality anticipated with implementation of any of the alternatives under consideration.

MICHAEL C. PETERSON
Environmental Engineer

Table 1 Existing and known future estimated emissions of air pollutants at Washington Aqueduct facilities.

Pollutant	Dalecarlia WTP (tons per year)	McMillan WTP (tons per year)	Residuals Process (tons per year)	Washington Aqueduct Total (tons per year)
Volatile Organic Compounds	2.74	0.10	1.81	4.65
Carbon Monoxide	0.22	0.52	8.96	9.7
Nitrogen Oxides (NOx)	0.45	2.33	7.14	9.92
Particulate Matter (PM-10)	0.15	0.08	0.09	0.32
Particulate Matter (PM-2.5)	NA	NA	0.07	0.07
Sulfur Dioxide	0.45	0.32	0.1	0.87

Table 2 Estimated emissions of air pollutants associated with deliveries of different chemicals for disinfection and pH control.

Pollutant	Liquid Chlorine (tons per year)	Bulk Hypochlorite (tons per year)	Sodium Chloride (tons per year)	Lime Alone (tons per year)	Lime + Caustic Soda (tons per year)	Caustic Alone (tons per year)	Sulfuric Acid (tons per year)
Volatile Organic Compounds	0.05	0.72	0.19	0.05	0.06	0.10	0.02
Carbon Monoxide	0.25	3.5	0.95	0.26	0.30	0.50	0.14
Nitrogen Oxides (NOx)	0.19	2.8	0.75	0.21	0.23	0.40	0.11
Particulate Matter (PM-10)	0.002	0.03	0.009	0.003	0.003	0.005	0.001
Particulate Matter (PM-2.5)	0.002	0.03	0.008	0.002	0.002	0.004	0.001
Sulfur Dioxide	0.003	0.04	0.01	0.003	0.006	0.01	0.002

Table 3 "Worst case" emissions with the proposed action, cumulative impact, and comparison with de minimus thresholds.

Pollutant	“Worst Case” combination (tons per year)	Cumulative Emissions with Implementation of the “Worst Case” combination (tons per year)	De Minimus Thresholds (tons per year)
Volatile Organic Compounds	0.84	5.5	25
Carbon Monoxide	4.14	13.8	100
Nitrogen Oxides (NOx)	3.11	13.0	25
Particulate Matter (PM-10)	0.036	0.36	100
Particulate Matter (PM-2.5)	0.035	0.11	100
Sulfur Dioxide	0.052	0.92	100

ESTIMATED AIR EMISSIONS

EMISSION FACTORS USED

HYDROCARBONS*	2.1 g/mi
CARBON MONOXIDE*	10.34 g/mi
NITROGEN OXIDES*	8.13 g/mi

* EPA AP-42, M-258, TABLE 7.1.1

SULFUR DIOXIDE

ASSUME 500 PPM
0.9 SPECIFIC GRAVITY
30 mi/GAL FUEL EFFICIENCY

$$(500\,ppm)(0.9)(62.4\,lb/ft^3)(1\,ft^3/7.4805\,GAL)(1\,GAL/30\,mi)(64/32)$$
$$= 2.5(10)^{-4}\,lb/mi = 1.25(10)^{-7}\,ton/mi$$

PM 2.5 & PM 10

PER RESIDUALS EIS:

$PM_{2.5}$ EMISSIONS ANNUALLY = 0.169 ton/yr
PM_{10} EMISSIONS ANNUALLY = 0.210 ton/yr
MILES ANNUALLY = $1.87(10)^6$ mi/yr

ASSUMPTION:

SIMILAR SIZED VEHICLES WILL HAVE SIMILAR EMISSION

THEN FOR $PM_{2.5}$:

$$(0.169\,ton/yr)/(1.87(10)^6\,mi/yr) = 9(10)^{-8}\,ton/mi$$

AND FOR PM_{10}:

$$(0.210\,ton/yr)/(1.87(10)^6\,mi/yr) = 1.1(10)^{-7}\,ton/mi$$

U.S. ARMY, CORPS OF ENGINEERS
WASHINGTON AQUEDUCT DIVISION
DALECARLIA FILTER PLANT
5900 MacARTHUR BLVD. N.W.
WASHINGTON, D.C. 20016

PROJECT: HYPO/CAUSTIC EA
ENGINEER: MCP DATE:
CHECKED: DATE:
SCALE:

	ANNUAL DELIVERIES	ROUNDTRIP MILEAGE	HC (tons/year)	CO	NOx	SO_2	$PM_{2.5}$	PM_{10}
LIQUID CHLORINE	120	180	0.05	0.25	0.19	0.003	0.002	0.002
BULK HYPOCHLORITE	688	450	0.72	3.5	2.8	0.04	0.03	0.03
SODIUM CHLORIDE	186	450	0.19	0.95	0.75	0.01	0.008	0.009
LIME (ALONE)	115	200	0.05	0.26	0.21	0.003	0.002	0.003
LIME + CAUSTIC	130	200	0.06	0.30	0.23	0.006	0.002	0.003
CAUSTIC ALONE	221	200	0.10	0.50	0.40	0.01	0.004	0.005
SULFURIC ACID	42	200	0.02	0.14	0.11	0.002	0.001	0.001

Excerpts from:

Final Environmental Impact Statement for a Proposed Water Treatment Residuals Management Process for the Washington Aqueduct, Washington, D.C.

September 2005

Washington Aqueduct
Baltimore District USACE

Washington Aqueduct
Residual Management EIS
Air Quality
02/17/2005

	Assumptions			HC/VOC	CO	NOx	PM10	SO2
	# of Trips	Days/week	Miles/trip	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Truck Trips	20	6	150	4.3	21.3	16.8	0	0.3
				From Table 7.1.1 Nontampered Exhaust Emission Rates for Low Altitude Heavy Duty Diesel Powered Vehicles - Model years 1991 or later				
	Heat Input BTU/yr	NG Heat Content Btu/scf						
Bldg Heating	3.30E+09	1020		0	0.065	0.152	0	0
	Area (acres)							
Monofill	30	k =	0.35	0	0	0	0.36	0
	Solids Applied (tons/day)	U =	12					
	6310	M =	10					
			TOTALS =>	4.3	21.4	16.9	0.36	0.3

Given: Emission factors for Heavy Duty Diesel Powered Vehicles (AP-42, H-258, Table 7.1.1)

Model Years 1991 - 1997

Hydrocarbons (HC) = 2.1 grams/mile

Carbon Monoxide (CO) = 10.34 grams/mile

Nitrogen Oxides (NOx) = 8.13 grams/mile

Assumptions:

No. of truck trips = 20 ~~round~~ trips/day

No. of Days/week = 6 days

Miles Traveled = 150 miles/ ~~round~~ trip

Example Calculation:

$$\left[\frac{10.34 \text{ gms CO}}{\cancel{\text{mile}}}\right]\left[\frac{150\ \cancel{\text{miles}}}{\cancel{\text{trip}}}\right]\left[\frac{20\ \cancel{\text{trips}}}{\cancel{\text{day}}}\right]\left[\frac{6\ \cancel{\text{days}}}{\cancel{\text{week}}}\right]\left[\frac{52\ \cancel{\text{weeks}}}{\text{year}}\right]$$

$$\left[\frac{1\ \cancel{\text{pound}}}{453.6\ \cancel{\text{gms}}}\right]\left[\frac{1 \text{ ton}}{2000\ \cancel{\text{lbs}}}\right]\left[\frac{2\ \cancel{\text{trips}}}{\text{round trip}}\right]$$

$$= \underline{21.3 \text{ tons/year}} \text{ CO}$$

$\frac{8.13 \text{ gms } NO_x}{\text{mile}} \Rightarrow \underline{16.8 \text{ tons/year}}\ NO_x$

$\frac{2.1 \text{ gms HC}}{\text{mile}} \Rightarrow \underline{4.3 \text{ tons/year}}$ HC

Sulfur Emissions based on:

Fuel efficiency = 30 miles/gallon

Sulfur Content of fuel = 0.02 %

AP-42: Compilation of Air Pollutant Emission Factors

Historically, EPA has produced the report "Compilation of Air Pollutant Emission Factors." "Volume I: Stationary Point and Area Sources" is available from EPA's Office of Air Quality Planning And Standards. This document includes emission factors for "fugitive dust" on roadways. AP-42 section 13.2.1 contains emission factors for paved roads; unpaved road emission factors are in section 13.2.2.

"Volume II: Mobile Sources" (commonly referred to as "AP-42") is no longer maintained. More current mobile source emission factors are available using the Office of Transportation and Air Quality (OTAQ) mobile source models.

However, for reference purposes, we continue to post parts of the most recent mobile sources AP-42 on this web page. In particular, Appendix H is still useful in documenting the emission factors produced by MOBILE5, and in some cases carried over into MOBILE6 without additional documentation.

Contact: ASD Information, phone (734) 214-4636 or email: asdinfo@epa.gov for further information and documents and other information contained on this web page.

In its first edition (1978), Volume II of AP-42 contained all available information about mobile source emission factors, including the source code listing of the MOBILE1 highway vehicle emission factor model. As the underlying data sets on in-use emission levels were expanded, EPA's understanding of the many parameters influencing in-use vehicle emission levels increased, and the MOBILE program steadily grew in complexity and sophistication, both to account for these parameters and to provide more user-controlled options. Thus in later updates to AP-42 Vol. II, it was no longer feasible to provide complete listings of all emission factors. The structure of the last complete update to AP-42 Volume II (4th Edition, 1989; Supplement A, 1991) included in Section I extensive background information and documentation about the highway vehicle emission factor model (at that time, MOBILE5), and included hundreds of tables presenting of both values used in the model and "look-up tables" of emission factors produced by the model for various conditions.

Section II provided emission factor information, in the form of look-up tables, for a wide range of off-road mobile sources (including agricultural equipment, construction equipment, lawn and garden equipment, aircraft and aircraft engines, locomotives, marine vessels, and miscellaneous types of equipment). Much of the information presented in Section II had not been updated since it was first compiled in the 1970s, and so did not reflect changes in technology that took place even in the absence of emission standards and other regulatory requirements.

About Portable Document Format Files

Highway Vehicles

In the early 1990s, OTAQ began to develop a 5th edition of AP-42 Volume II, based on the MOBILE5 highway vehicle emission factor model. The following sections of the planned 5th edition of AP-42 Vol. II were completed and posted on the web:

- Appendix G: Sample Calculation of Motor Vehicle Emissions
- Appendix H: Highway Mobile Source Emission Factor Tables
- Appendix I: Emission Sensitivity Tables -- All Vehicles Combined
- Appendix J: Emission Sensitivity Tables -- By Vehicle Type
- Appendix K: Emission Sensitivity Tables -- Air Conditioning and Extra Loads

Appendix G: Sample Calculation of Motor Vehicle Emissions
115K PDF

Appendix H: Highway Mobile Source Emission Factor Tables

- List of Tables in Appendix H 6K TXT or 7K PDF
- Individual Text Tables
- Light-Duty Gasoline Vehicles 119K PDF
- Light-Duty Gasoline Trucks-1 117K PDF
- Light-Duty Gasoline Trucks-2 109K PDF
- Heavy-Duty Gasoline Trucks 87K PDF
- Light-Duty Diesel Vehicles 43K PDF
- Light-Duty Diesel Trucks 41K PDF
- Heavy-duty Diesel Trucks 42K PDF
- Motorcycles 63K PDF
- All Vehicles 200K ZIP WPD

Appendix I: Emission Sensitivity Tables -- All Vehicles Combined
Full Document, introduction and tables 155K PDF or Directory of Individual Tables

Appendix J: Emission Sensitivity Tables -- By Vehicle Type
Full Document, introduction and tables 155K PDF or Directory of Individual Tables

Appendix K: Emission Sensitivity Tables -- Air Conditioning and Extra Loads
Full Document, introduction and tables 37K PDF or Directory of Individual Tables

Appendix G describes the major steps used in MOBILE5 to calculate average in-use emissions for the specific case of exhaust hydrocarbons (HC) from light-duty gas vehicles. Appendix H consists of several hundred tables that document many of the

U.S. EPA
AP-42

TABLE 7.1.1
NONTAMPERED EXHAUST EMISSION RATES FOR
LOW ALTITUDE
HEAVY DUTY DIESEL POWERED VEHICLES
* BER = ZML + (DR * M)

Pol	Model Years	Zero Mile Emission Level	Deterioration Rate	50,000 Mile Emission Level	100,000 Mile Emission Level
HC	Pre-1967	3.540	0.060	3.840	4.140
	1967-1968	3.660	0.060	3.960	4.260
	1969	3.780	0.060	4.080	4.380
	1970	3.810	0.060	4.110	4.410
	1971-1973	3.910	0.060	4.210	4.510
	1974-1976	3.910	0.060	4.210	4.510
	1977	3.990	0.060	4.290	4.590
	1978	3.920	0.060	4.220	4.520
	1979	3.510	0.000	3.510	3.510
	1980-1981	3.170	0.000	3.170	3.170
	1982	2.780	0.000	2.780	2.780
	1983	2.660	0.000	2.660	2.660
	1984	2.820	0.000	2.820	2.820
	1985	2.590	0.000	2.590	2.590
	1986	2.280	0.000	2.280	2.280
	1987	2.230	0.000	2.230	2.230
	1988-1989	2.180	0.000	2.180	2.180
	1990	2.130	0.000	2.130	2.130
	1991-1997	2.100	0.000	2.100	2.100
	1998-2000	2.100	0.000	2.100	2.100
	2001+	2.100	0.000	2.100	2.100
CO	Pre-1967	10.320	0.140	11.020	11.720
	1967-1968	10.690	0.150	11.440	12.190
	1969	11.040	0.150	11.790	12.540
	1970	11.130	0.150	11.880	12.630
	1971-1973	11.420	0.160	12.220	13.020
	1974-1976	11.420	0.160	12.220	13.020
	1977	11.650	0.160	12.450	13.250
	1978	11.440	0.160	12.240	13.040
	1979	14.040	0.120	14.640	15.240
	1980-1981	12.670	0.110	13.220	13.770
	1982	11.120	0.100	11.620	12.120
	1983	10.660	0.090	11.110	11.560
	1984	11.260	0.100	11.760	12.260
	1985	10.350	0.090	10.800	11.250
	1986	10.360	0.090	10.810	11.260
	1987	10.140	0.090	10.590	11.040
	1988-1989	9.900	0.080	10.300	10.700
	1990	9.670	0.080	10.070	10.470
	1991-1997	9.540	0.080	9.940	10.340
	1998-2000	9.530	0.080	9.930	10.330
	2001+	9.520	0.080	9.920	10.320
NOx	Pre-1967	22.990	0.170	23.840	24.690
	1967-1968	23.830	0.180	24.730	25.630
	1969	24.590	0.180	25.490	26.390
	1970	24.800	0.190	25.750	26.700
	1971-1973	25.460	0.190	26.410	27.360
	1974-1976	25.440	0.190	26.390	27.340
	1977	25.970	0.190	26.920	27.870
	1978	25.500	0.190	26.450	27.400
	1979	23.780	0.000	23.780	23.780
	1980-1981	21.470	0.000	21.470	21.470
	1982	18.840	0.000	18.840	18.840
	1983	18.060	0.000	18.060	18.060
	1984	19.080	0.000	19.080	19.080
	1985	17.530	0.000	17.530	17.530
	1986	17.560	0.000	17.560	17.560
	1987	17.180	0.000	17.180	17.180
	1988-1989	16.770	0.000	16.770	16.770
	1990	9.870	0.000	9.870	9.870
	1991-1997	8.130	0.000	8.130	8.130
	1998-2000	6.490	0.000	6.490	6.490
	2001+	6.490	0.000	6.490	6.490

* WHERE : BER = Nontampered basic exhaust emission rates in grams/mile,
ZML = Zero mile level in grams/mile,
DR = Deterioration rate in grams/mile/10K miles,
M = Cumulative mileage / 10,000 miles.

DATE : JUNE 30, 1995

Washington Aqueduct
Residual Management EIS
Air Quality
02/17/2005

	Assumptions			HC/VOC	CO	NOx	PM10	SO2
	# of Trips	Days/week	Miles/trip	(tpy)	(tpy)	(tpy)	(tpy)	(tpy)
Truck Trips	20	6	150	4.3	21.3	16.8	0	0.3
				From Table 7.1.1 Nontampered Exhaust Emission Rates for Low Altitude Heavy Duty Diesel Powered Vehicles - Model years 1991 or later				
	Heat Input BTU/yr	NG Heat Content Btu/scf						
Bldg Heating	3.30E+09	1020		0	0.065	0.152	0	0
	Area (acres)							
Monofill	30	k =	0.35	0	0	0	0.36	0
	Solids	U =	12					
	Applied	M =	10					
	(tons/day)							
	6310							
			TOTALS =>	4.3	21.4	16.9	0.36	0.3

Given: Emission Factors for Heavy Duty Diesel Powered Vehicles (AP-42, H-258, Table 7.1.1)

Model Years 1991 - 1997

Hydrocarbons (HC) = 2.1 grams/mile

Carbon Monoxide (CO) = 10.34 grams/mile

Nitrogen Oxides (NO_x) = 8.13 grams/mile

Assumptions:

No. of truck trips = 20 ~~round~~ trips/day

No. of Days/week = 6 days

Miles Traveled = 150 miles/ ~~round~~ trip

Example Calculation:

$$\left[\frac{10.34 \text{ gms CO}}{\text{mile}}\right]\left[\frac{150 \text{ miles}}{\text{trip}}\right]\left[\frac{20 \text{ trips}}{\text{day}}\right]\left[\frac{6 \text{ days}}{\text{week}}\right]\left[\frac{52 \text{ weeks}}{\text{year}}\right]\left[\frac{1 \text{ pound}}{453.6 \text{ gms}}\right]\left[\frac{1 \text{ ton}}{2000 \text{ lbs}}\right]\left[\frac{2 \text{ trips}}{\text{round trip}}\right]$$

$$= \underline{21.3 \text{ tons/year}} \text{ CO}$$

$\frac{8.13 \text{ gms } NO_x}{\text{mile}} \Rightarrow \underline{16.8 \text{ tons/year}}\ NO_x$

$\frac{2.1 \text{ gms HC}}{\text{mile}} \Rightarrow \underline{4.3 \text{ tons/year}}$ HC

Sulfur Emissions based on:

Fuel efficiency = 30 miles/gallon

Sulfur Content of fuel = 0.02 %

Mobile Source Emissions - Past, Present, and Future

MOBILE Model (on-road vehicles)

NONROAD Model (nonroad engines, equipment, and vehicles)

MOVES (Motor Vehicle Emission Simulator)

Fuels Models

AP-42: Compilation of Air Pollutant Emission Factors

[Introduction] [Highway] [Nonroad]

Historically, EPA has produced the report "Compilation of Air Pollutant Emission Factors." "Volume I: Stationary Point and Area Sources" is available from EPA's Office of Air Quality Planning And Standards. This document includes emission factors for "fugitive dust" on roadways. AP-42 section 13.2.1 contains emission factors for paved roads; unpaved road emission factors are in section 13.2.2.

"Volume II: Mobile Sources" (commonly referred to as "AP-42") is no longer maintained. More current mobile source emission factors are available using the Office of Transportation and Air Quality (OTAQ) mobile source models.

However, for reference purposes, we continue to post parts of the most recent mobile sources AP-42 on this web page. In particular, Appendix H is still useful in documenting the emission factors produced by MOBILE5, and in some cases carried over into MOBILE6 without additional documentation.

Contact: ASD Information, phone (734) 214-4636 or email: asdinfo@epa.gov for further information and documents and other information contained on this web page.

In its first edition (1978), Volume II of AP-42 contained all available information about mobile source emission factors, including the source code listing of the MOBILE1 highway vehicle emission factor model. As the underlying data sets on in-use emission levels were expanded, EPA's understanding of the many parameters influencing in-use vehicle emission levels increased, and the MOBILE program steadily grew in complexity and sophistication, both to account for these parameters and to provide more user-controlled options. Thus in later updates to AP-42 Vol. II, it was no longer feasible to provide complete listings of all emission factors. The structure of the last complete update to AP-42 Volume II (4th Edition, 1989; Supplement A, 1991) included in Section I extensive background information and documentation about the highway vehicle emission factor model (at that time, MOBILE5), and included hundreds of tables presenting of both values used in the model and "look-up tables" of emission factors produced by the model for various conditions.

Section II provided emission factor information, in the form of look-up tables, for a wide range of off-road mobile sources (including agricultural equipment, construction equipment, lawn and garden equipment, aircraft and aircraft engines, locomotives, marine vessels, and miscellaneous types of equipment). Much of the

Key Topics: Transportation and Air Quality

Overview: Pollutants and Programs

Consumer Information

On-road Vehicles and Engines

Nonroad Engines, Equipment, and Vehicles

Fuels and Fuel Additives

Voluntary Programs

Transportation and Air Quality Planning

Modeling, Testing, and Research

information presented in Section II had not been updated since it was first compiled in the 1970s, and so did not reflect changes in technology that took place even in the absence of emission standards and other regulatory requirements.

About Portable Document Format Files

Highway Vehicles

In the early 1990s, OTAQ began to develop a 5th edition of AP-42 Volume II, based on the MOBILE5 highway vehicle emission factor model. The following sections of the planned 5th edition of AP-42 Vol. II were completed and posted on the web:

- Appendix G: Sample Calculation of Motor Vehicle Emissions
- Appendix H: Highway Mobile Source Emission Factor Tables
- Appendix I: Emission Sensitivity Tables -- All Vehicles Combined
- Appendix J: Emission Sensitivity Tables -- By Vehicle Type
- Appendix K: Emission Sensitivity Tables -- Air Conditioning and Extra Loads

Appendix G: Sample Calculation of Motor Vehicle Emissions
115K PDF

Appendix H: Highway Mobile Source Emission Factor Tables

- List of Tables in Appendix H 6K TXT or 7K PDF
- Individual Text Tables
- Light-Duty Gasoline Vehicles 119K PDF
- Light-Duty Gasoline Trucks-1 117K PDF
- Light-Duty Gasoline Trucks-2 109K PDF
- Heavy-Duty Gasoline Trucks 87K PDF
- Light-Duty Diesel Vehicles 43K PDF
- Light-Duty Diesel Trucks 41K PDF
- Heavy-duty Diesel Trucks 42K PDF
- Motorcycles 63K PDF
- All Vehicles 200K ZIP WPD

Appendix I: Emission Sensitivity Tables -- All Vehicles Combined
Full Document, introduction and tables 155K PDF or Directory of Individual Tables

Appendix J: Emission Sensitivity Tables -- By Vehicle Type
Full Document, introduction and tables 155K PDF or Directory of Individual Tables

Appendix K: Emission Sensitivity Tables -- Air Conditioning and Extra Loads
Full Document, introduction and tables 37K PDF or Directory of Individual Tables

Appendix G describes the major steps used in MOBILE5 to calculate average in-use emissions for the specific case of exhaust hydrocarbons (HC) from light-duty gas vehicles. Appendix H consists of several hundred tables that document many of the